COAL AGE

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DEVOTED TO THE OPERATING, TECHNICAL AND BUSINESS PROBLEMS OF THE COAL-MINING INDUSTRY

SYDNEY A. HALE, *Editor*

New York, July, 1932

O'Brian vs. Donovan

APPLICATION of the Department of Justice to have Appalachian Coals, Inc., outlawed under the Sherman Act opens the way for judicial determination of an issue which vitally affects all industry. That issue is whether the framework of legislation enacted over forty years ago is flexible enough to support the changing economic conditions of today. The necessity for reform in the wasteful and ruinous marketing methods of bituminous coal is unchallenged—even by the bitterest critics of mining. The single question authoritatively unanswered is whether such reform can be effected without violence to the law. The Department of Justice doubts it; the Donovan school of lawyers insists that the self-control contemplated in the district sales agency plan is fully in tune with the spirit of the act. Should the O'Brian interpretation be upheld, then industry must press the fight for modification of the law iself.

Anthracite Accident Rates

IN ALL COAL MINES, the present widespread depression and the warm winters have increased safety by closing down many of the weakling and less safe operations, though in the anthracite region, differential wages in favor of the smaller companies have kept many of the less financially able concerns alive. Nevertheless, the accident record is improving, probably because the big companies are closing down their less safe mines, animated by a desire to avoid the high cost their operation entails.

Many such mines have been closed, and safety increased accordingly. Some may say that the safest mine is one naturally unsafe, and certain companies have demonstrated that a large degree of risk is followed by such stringent rules, close supervision, and drastic discipline as to put the unsafe mine in the lead in its safety record, but such reversals of the course of nature are exceptional.

Some credit should be given, however, to the advent into the anthracite region of men brought up under the severest of safety training and discipline, and who have ideas drawn from regions where pillar drawing is not exceptional but well-established practice. At least, three companies are already providing long break lines when drawing pillars. Another favorable condition has been operation of thin seams and the use of protective hats in seams that are thick.

Still Standing but Useless

TIMBER which is rotten has no sustaining power. After a year of exposure, the untreated timber in return air where bacteria are rife may have a goodly appearance and yet have lost most of its strength. Sometimes even six months may suffice to riddle the timber so that it may at any time break and let down the rock above. The gangway may be wholly unsafe or dependent largely on new sets of timber placed between the older sets. This is a risk that no manager would care to take.

Furthermore, when a mine is shut down, the timbering cost does not cease; in fact, it increases. If the ventilation is shut off, the deterioration is immensely more rapid than ever. This can be avoided by continuing to ventilate the mine, but only at considerable cost. If the fan is run at slow speed, the deterioration in returns is little less than at normal speed, fan and motor run inefficiently, and the cost of ventilation is not reduced according to the decrease in volume. When a mine is closed down, it is

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a fortunate circumstance if its timber is well treated and capable in itself of resisting deterioration.

If crush or abandonment of a gangway causes this treated timber to serve only between $5\frac{1}{2}$ and $5\frac{3}{4}$ years, the treated timber will justify its use solely by reason of the life accorded it, without considering the value derivable from having timber that will sustain almost as much on the last day of service as on the first.

Still Vicious

SENATOR DAVIS' amendments to the Davis-Kelly bill, submitted to the Senate subcommittee on mines and mining after the close of the hearings last month, fall far short of removing the cardinal objections to that measure. While he definitely prohibits zoning by his proposed Bituminous Coal Commission, shifts the costs of administration to the industry, provides for court review of the Commission's orders and eliminates the section which would have made the Interstate Commerce Commission and the railroads subject to his coal commission in the matter of switch connections to mines, the vicious basic principles of the bill are unaltered. Unionization by fiat remains. The "permission" to form marketing pools, open to operators accepting compulsory unionization, can have no lure to an industry which is now awaiting judicial decision on that question. And nothing in the pages of testimony taken at the subcommittee hearings has established justification for such a further invasion into the domain of private business as the authors of this bill propose.

Start Capital Goods

MONTH-END reports from Washington held out the hope that the relief bills then in conference might be amended to authorize the Reconstruction Finance Corporation to loan money to private industry where such funds, properly secured, were not available through ordinary channels of finance. Should Congress decline to agree to that method of stimulating a revival in the purchase of capital goods (and, in all probability, Congress will have answered before this issue of *Coal Age* is in the hands of its readers), it may be necessary to fall back upon the provisions of the Glass-Steagall law, which broadened the base for commercial paper eligible for rediscount at the Federal Reserve banks, to induce timid bankers to advance, and timid industry to accept, funds on long-term commitments for modernizing plant equipment.

As stated in these columns last month, it is imperative that something be done to encourage the movement of capital goods if the nation is to end increasing unemployment. Use of the machinery of the Reconstruction Finance Corporation to initiate such a movement would have the psychological advantage of being a direct mandate from Congress that the movement should be started. But to do nothing because such a mandate may be lacking is to invite further decline in business, further widespread personal distress and suffering, and further taxation to finance unofficial or official doles.

Explosive Water Pipes

THAT dangerous quantities of combustible gas may accumulate in pipes which convey acid water is well established. At a Pennsylvania mine, a man opened the vent of a siphon at the summit and the gas ignited with a violent explosion. On another occasion, a man opening the plug at the top of a siphon, held his light down near the pipe, and a flash occurred which burned off the whiskers on one side of his face. Others have been burned while opening and examining split centrifugal pumps. Knowledge of such burnings seems common, though safety men are none too generally informed as to the hazard.

In general, the phenomena are ascribed to sulphuretted hydrogen, the presence of that gas being attested by the smell, but this is an unlikely conclusion, because that gas is lethal far and away below its explosive limit. Others believe the gas is methane, which, indeed, may often be true, for where coal forms the bottom of a sump, or lies still further below the coal being mined, methane may rise through the water, pass into a submerged pipe and enter the water line above it, where it will accumulate if the pipe is bent downward in its course. Hydrogen may be found in acid mines wherever there are metals and especially is it likely to be found in pipes, because there is often no movement of the gas to carry it away. The gas also may be generated whenever coal is allowed to slide down or lie on zinc-coated plates.

ILLINOIS MINE TESTS

+ Establish Advantages of Tipping Bits With Abrasion-Resisting Alloy

By A. F. BROSKY

Associate Editor, Coal Age

IN THE two years prior to the general shutdown of shaft mines pending a wage settlement in Illinois, the Old Ben Coal Corporation gained wide experience in the use of abrasion-resisting material applied to the tip of cutting-machine bits. Results therefrom proved satisfactory in every phase of mine-plant operation where cutting played a part. The special bits were used on only a few machines at first. When the management discovered that the processing gave great promise, the mine was reverted back to the old status of using common bits; this step was taken as an opportunity to gather cost figures and other data on the old basis of cutting for use as a yardstick for measuring subsequent accomplishments as the technique of bit treating was developed. Base figures were not collected until after common bits and their use had been improved as much as possible.

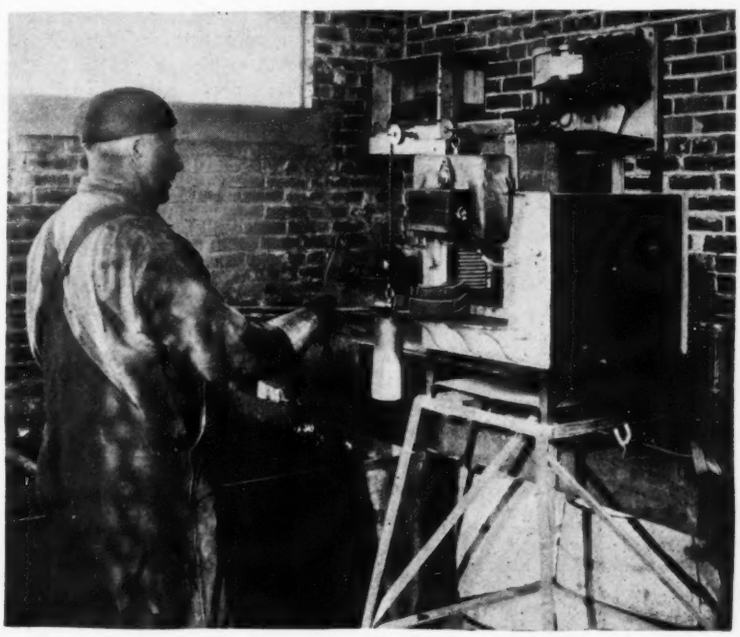
The material with which the bits are tipped is Blackor, a tungsten carbide compound having an excess of carbon, this last element serving as a reducing agent in the metallurgical process. It is applied by electric welding, and as the final step the bits are heat-treated in an electric oven. The Blackor is applied in such quantity that 1 lb. will treat as many as 460 bits. Experience has shown, however, that a fairly heavy coating—that obtained when only 300 to 350 bits are treated per pound of material—gives best results. The bit stock to which the Blackor is applied is an inexpensive nickel-molybdenum alloy steel costing about 5c. per pound.

Beginning with July 16, 1930, the output of the entire mine was cut with the special bits. During the first three pay periods, which afforded 37 working days, 3,427 places were cut with 10,938 bit changes, including the bits that were lost. The mine in that period produced 137,293 tons, or 12.5 tons per bit use. Actual counting in the test period for the common bit showed that the common bit yielded only 1.1 tons per bit used. At these comparative rates, the special bit cut 11.3 times as much coal as the common bit per use. Broadly speaking, these results furnished the best proof of the improvement, for in this initial period of cutting the entire output with the special bits, conditions were little changed from what they had been when common bits were used. Later on, the special bits were subjected to harder and harder cutting for gain of other operating and face-preparation advantages, with the result that the ratio of service, in tons per use, between the quality and common bits was accordingly reduced.

In the 37 working days beginning with July 16, 1930, an average of 295 special bits was used per day. As during the test period for the common bits, accurate records were kept. Each machine was allocated a fixed number of bits, and only as many sharp bits were sent in to each as were sent out. Every day the face bosses were required to record the number of places cut, the number of bits used and the number lost. Sixteen machines, all of the short-wall type, were required to cut a day's output. Half of them cut coal of average hardness; the remainder encountered relatively hard cutting.

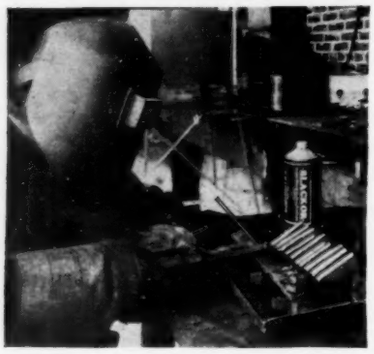
Cumulative results from July 16, 1930, to Jan. 1, 1931, were as follows: Places cut, 11,587; bit uses, 27,339; and tonnage produced, 462,209. This gave an output of 9.8 tons per bit use. One reason for the lower result of the entire five-month period as compared with the first 1½ months has already been given: namely, the shift to harder cutting. A second factor was that considerable experimenting was in progress both in the process of applying the Blackor to the

Charging the Bits Into the Furnace



bits and in the heat-treating which follows. During this last leg of the test the actual welding and heat-treating were done by a demonstrator furnished by the Blackor Co. under the direction of a technical representative of the Mine Safety Appliances Co.

In the month of September, 1931, the mine worked 24 days and produced 90,872 tons of coal with 10,463 bit uses. In 4,830 instances the bit tip was found



Reducing the Ore to Metal by Electric Welding

to have sufficient welded-on abrasion-resisting material that it could be conditioned for re-use merely by grinding. In the remaining 6,633 instances a fresh coating was applied. Following are the reasons given for the drop in the tonnage output per bit use: (1) Increase in the number of bits reground; (2) decrease in the quantity of Blackor applied to each bit; (3) shortening of steel stock and deterioration of the steel through contamination (to prevent this, the bit point should be sheared off after each eight to ten treatments); (4) increase in the percentage of hard cutting (at first, the management and the machine runners hesitated to attempt hard cutting); and (5) cutting black jack, which would not be attempted with ordinary bits.

During September, 1931, there were 6,780 applications of Blackor to bits, using 22.6 lb. of material, or 300 bits to the pound. Of the total number of treatments, only 5,633 uses were made of the bits, so that the quantity of Blackor actually consumed in the month was 18.7 lb. At $7.50 per pound (price prevailing at the time for small purchases of material), 18.7 lb. cost $140.25. The average daily replacement of bit stocks during the year was 20, and the cost of each new bit was 3c. At this rate, in the 24 working days of the month, new bits cost $14.40. Treatment required the labor of two men for six hours each day, and the wage per hour was 75c. The labor cost for 24 days, therefore, was $218.88.

The total cost of all items for the 24 days was $373.53, or $15.55 per day. As against this, common bits cost $17.15 per day. This last account is made up of the wages of two men for eight hours each day, or $12.15, and the replacement of 250 common bits each day, which, at 2c. each, amounted to $5. No record was kept of the cost of other incidental items, which, in each case, was small.

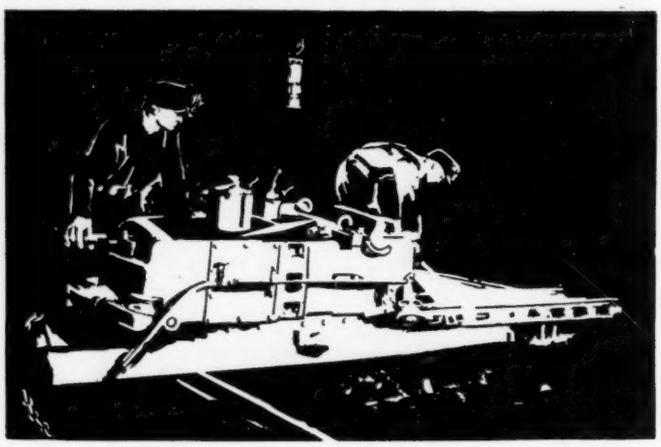
A number of advantages obtainable below ground follow: (1) Lower cost of bit delivery, as the number distributed is smaller; (2) minimum of lost time waiting for bits because so few are used; (3) greatly decreased cost of machine maintenance (estimated to be about 40 per cent) and saving in power; (4) ability to cut hard places, this without resumping or changing bits, which could not be done by machines equipped with common bits; (5) less fine dust at the face, because the cutting edges stay sharp and do not rub off the coal, the result being that safer conditions prevail—vision is better, irritation of the respiratory system is lessened, and injuries caused by changing bits, with the cutter bar under coal, are lessened; (6) time is saved in changing bits.

At this mine five complete bit changes are saved each shift. As it takes two men an average of 15 minutes to change a set of bits, the saving in the labor of two men at a wage of $1.25 per hour per man amounted to $3.125 per shift. Besides the advantages above enumerated, better satisfied machine runners are the result.

Before worn bits are retipped, they are heated and reforged in the usual manner in a Sullivan sharpener. The Blackor is applied to the bits with a General Electric 300-amp. arc welder, set at 30 volts and 40 amp. The bits are heat-treated in an electric furnace furnished by the Hevi Duty Electric

The Finished Product

Co. After the material is applied, the bits are quenched in water; then they are placed in the furnace, where they are brought to a heat of 1,490 deg. F. and maintained at that temperature for ten minutes. At the termination of this first heat the bits are placed in the water bath and allowed to cool. The bits are again placed in the furnace and brought to a temperature of 775 deg. F. They are held at this temperature for 30 minutes and finally quenched in water. The metal coating on the bit, as thus applied, forms a satisfactory bond with the steel bit stock, and is resistant to shock. It is said that the qualities of the finished job are equivalent to case-hardening. A further claim is that the resistance to abrasion is equal to that of Carborundum, with an index of 9 in a scale representing the diamond with an index of 10.



MAINTENANCE FACTORS

+ In Mechanical Loading*

By K. E. CAINE

Mining Engineer
Joy Manufacturing Co.

IF mining machines could talk, what a story some would tell! "I'm not fit to work, but my boss drives me on day after day; and when I stop, he cusses me, patches me up after a fashion, and sets me to work again. Eventually I shall have a complete breakdown, and he will get big bills for putting me back in shape. The money he will have to spend would pay the cost of reasonable care to keep me going many years. I was strong once and should be today. So it's not my fault, I tell you. It's downright carelessness, that's all." And the machine would be right.

There is no mystery to low maintenance cost and insurance against operating losses from breakdowns. It is altogether a matter of care. If loading machines require more care than other mining equipment, it is because the work they must do is least set to pattern and hardest. But that is no excuse for major breakdowns, for these machines are designed for hard service.

Close, regular inspection and methodical attention to lubrication of all bearing surfaces are primary requisites to preserving the machine closest to its "as new" condition. But certain parts will wear or enter into early stages of mechanical failure, despite this care. Inspection makes the discovery in time to allow replacement of those parts before breakdown and operating losses occur.

But visual inspection alone cannot be relied upon entirely to determine the condition of a machine. Operating characteristics should be studied for symptoms of weakness. One way to check visual findings, used at an operation in Utah, is to take watt-hour readings on each machine at stipulated intervals to determine the average unit power demand. When plotted graphically, these readings give vital information of machine condition, for any decided increase in power consumption for a set duty can mean nothing but an impaired mechanism which may require little correction if handled promptly.

Records, too, play a supporting rôle in the determination of repair or overhauling needs by enabling management to check quickly and accurately the condition of the machine against performance figures. Records of oil consumption assist this determination. When compared with the labor and parts cost of repairs, they fix or indicate the time the unit should be given a general overhauling. Information of this kind has further value in that it tells the mechanical department when to expect the job, allows advance planning, and avoids costly overtime charges.

No cause of machine failure is more prevalent than improper lubrication. Inferior lubricants and good lubricants incorrectly applied leave behind them a train of consequences at a cost that may absorb the economy advantages of machine loading. In the cost of machine-crew idleness alone, delays penalize inherent savings at the rate of 12 to 20c. per minute.

At some mines the loading machine runner is required to lubricate his machines after the end of the production shift, at extra pay for as much as an hour. In such cases the man invariably will commence to oil or grease his unit before regular quitting time in order to finish early. He will not take time to insure that all bearings are amply greased, particularly if the lubricator is clogged. Nor can he with propriety be censured for this, since he is working at the fag end of the shift. Also wrong is the practice of having the runner lubricate his machine within the working shift, during delay intervals caused by car shortage, power interruptions, or for other reasons. In a coordinated operation, these delays are too infrequent and of insufficient duration to make such a method feasible.

There are exceptions, however, to any general rule. Where a machine is isolated from the main productive sections, or in a mine where but one or two loaders are in use, a runner might well be required to lubricate the unit he operates. In these circumstances laxity can be circumvented by close supervision by the mine management.

Experience records based on long periods of practical test show that high-capacity loading machines should be lubricated only by men trained to perform this work correctly, and not by the machine operator. Responsibility for thorough lubrication must be delegated to men thoroughly familiar with the mechanism of the loading units. This practice makes rigid discipline possible and eliminates alibis for machine failure that are offered when definite responsibility is not fixed.

Two men working on off-shifts can lubricate four to six mobile loaders in eight hours. They should be provided with a locomotive and trucks for carry-

The problem of controlling maintenance expenditures has grown in proportion with the trend toward increased use of underground loading machinery. And the key to this control is budgeting, which can be made accurate if maintenance methods and their enforcement are what they should be. Close cooperation between the manufacturer and the coal operator is solving a number of the maintenance problems. Many of the ideas concerning improvements of design come direct from the mine mechanic, especially improvements relating to the ease with which units may be dismantled for repair. By this concurrent effort, complicated problems are being simplified and machinery is being provided that will operate continuously with minimum maintenance. These factors combine to further the economic stability of modernization.

*This is the last of a series of five articles by Mr. Caine treating the problems encountered in mechanical loading. The first of these dealt with principles of mechanization, Vol. 36, p. 525; the second with haulage, Vol. 36, p. 580; the third with face preparation, Vol. 36, p. 625; the fourth with cost accounting, Vol. 37, p. 7.

ing portable lubricators, lubricants, tools, and materials for minor repairs.

High-pressure, truck-mounted greasing machines have proved their worth at several mechanized mines. These are trammed to the various underground sections and each loading unit is lubricated in turn. For a description of one of these greasing machines, that used by the Valier Coal Co., see *Coal Age*, Vol. 36, p. 552. Advantages derivable from such a machine are: positive, high-pressure lubrication of all bearings; absolute check on the quantity of grease and oil applied to each individual unit; minimum loss of oil and grease through spillage; no contamination of lubricant by foreign abrasive substance; elimination of storing of oil and grease in the productive workings; and minimum labor cost.

Either the face foreman or the runners should be required to turn in a report at the end of each shift indicating the condition of the machines. Guided by this report, night greasers or mechanics can organize their work intelligently. All repairs made at night should be noted on the back of the day-shift report and the latter turned over to the day foreman. Then the latter will know definitely the condition of his machines and can use this information to avoid impending mechanical failure.

Undeniably, lubrication is the most vital phase of machine maintenance. It is, therefore, at once a problem of the machine manufacturer, the operator, and the grease maker. The design engineer must assure himself of the practicability of the lubrication system he adopts; the maintenance department of the mine must have the ability to apply the oil and grease intelligently; and the grease manufacturer must be prepared to supply the correct product. The problem is not simple. Wide variation in the types of bearings, clutches, gears, chains, and other parts in loading equipment necessitates detailed analysis. Hit-or-miss methods may accidentally prove workable in a few cases, but for general application they will not yield satisfaction.

Quality lubricants have similar basic characteristics, the most important of which are as follows:

1. The viscosity, or body, should be such that a film of suitable thickness will be maintained between the wearing surfaces throughout the temperature range within which the machine is operated.

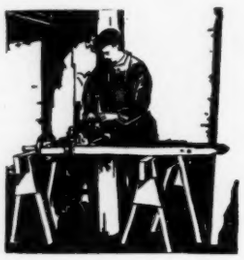
2. The viscosity of the lubricant should be such throughout the range of operating temperature that it can be held within the oil reservoir. If this factor is disregarded, considerable loss may result from waste leakage.

3. Its tendency to emulsify should be of as low degree as possible, for the lubricant may become mixed with small quantities of water.

4. It should be made of high-grade ingredients that are scientifically mixed. This is a necessary precaution with greases to insure against separation.

Maintenance study should not stop with the problems of lubrication and repair, for the manner in which machines are handled while performing their duties is of real importance. This is evidenced by the variation in cumulative maintenance costs of loading units of identical type operating in mines having similar physical conditions but under different management. Maintenance is closely allied with the mining phases of operation. Machines which must load from improperly prepared faces will have correspondingly high maintenance costs and low tonnage yield.

Sudden shocks and unbalanced stresses cause main frames to become sprung. However small the resulting misalignment of mechanical units, such misalignment will cause increased wear on gears, bearings, and shafts. In many



instances the distortion makes difficult the holding of oil or grease in the affected gear cases, with the result that lubricating costs are high. Only care and instruction in the handling of the machines at the face will eliminate these losses.

Low voltage is another cause of excessive maintenance costs and at the same time reduced machine output. Only with ample power supply will loading machines produce the tonnages for which they are designed and on which cost estimates are predicated. Failure to maintain voltage under full-load conditions has been the cause of many failures of loading machines to yield expected performance records.

Because the workings in mechanized mines are more concentrated than in hand-loading operations, the daily rate of extraction from a given area is often doubled by the use of loading machines. Therefore, underground generator sets must be moved frequently to keep line losses at a minimum. This problem is simplified by the use of a.c. power, which has proved its efficiency for face operations and shown its superiority over direct current in the matter of electrical maintenance in mechanized mines. Transformer sets having the capacity required for operating all the machines in a panel or section, built in a steel frame and mounted on portable trucks, can be kept in close proximity to the point of power consumption at a cost much less than for d.c. motor-generator or rotary-converter sets.

It is a certainty that a.c. units will not be abused by operation on low voltage, as they cannot be so operated. Voltage must be maintained within certain absolute limits with a.c. units or they will not run at all. Because this is not the case with direct current, electrical equipment often is abused.

Electrical safety devices placed on loading machines are not always kept operative—cable fuses and circuit breakers especially, which are purposely made ineffective by shorting. The consequence is the "burning up" of controller or motor.

Standardization of equipment should be the practice in so far as it is practicable. That policy reduces the number of spare parts that must be kept in the stockroom and simplifies general maintenance work. It has not been a policy in the mining industry to a degree comparable with that of other major industries. Much of this lack of standardization has, no doubt, followed from the rapid development of new types of mine equipment in recent years.

That certain specific repair parts be kept in the vicinity of the operating units is essential. It is not uncommon to see a machine idle for hours that could have been repaired and placed back in production in a few minutes, had it not been necessary to bring in the required parts from the outside supply house. The concentration of mechanized mining makes relatively simple the matter of keeping most-needed parts in a centrally located and locked box or bin. Repairmen and the face foreman, only, should have access to these parts, and it is essential, of course, that parts used be replaced promptly. The keeping of mining machine repair parts at the face in hand loading operations is not generally practicable because producing areas are widely scattered. But when loading machines are introduced this innovation must be made.

One repairman should be employed at the face during the day shift attending the minor mechanical failures on all face equipment. Under normal conditions he should be able to keep four to six loader units in operation, working from a "shanty" conveniently located in which to keep necessary tools and equipment, including a suitable work bench and a small vise.

In mines completely mechanized, spare units should be provided. Constant tonnage cannot be maintained otherwise. Major breakdowns will occur, and machines need occasional overhauling if the operation is to maintain a high level of efficiency. Where mobile type machines are used, one spare unit is sufficient for every ten or twelve that are operating. Spare units are especially needed where loaders are double- or triple-shifted.

DISPATCHING

+ Saves $46.44 Daily

At a Mechanized Mine in Ohio

By A. J. RUFFINI

Efficiency Engineer
Wheeling Township Coal Mining Co.
Adena, Ohio

RING goes the phone in a busy place.

"Hello!"

"Hello! Al?"

"Yes."

"This is Unit No. 3. Got ten coal."

"All right. There are ten empties on your track. Take all of them."

"Say, Al, on the next trip I'd like to have twelve empties, as we are going into a room with a breakthrough."

"O.K. I'll have them there for you."

The dispatcher no sooner gets the proper figures marked on his control sheet than the phone rings again.

"Hello!"

"Al?"

"Yes."

"No. 9 calling. Seven coal, two stone." (This is an entry unit.)

"Five cars on your track. Take all of them. What do you want for the next trip?"

"Why, eight will clean us up. Got an entry and a breakthrough."

"All right, I'll have them there for you."

All during the shift, Al's phone is ringing, for he not only dispatches the loads, empties and motors but also keeps track of all the face bosses, mine foremen and face mechanics, in order that they may be located at once if need be. He at the same time dispatches such supplies as posts and ties to the different units, these supplies going in with the regular motor trips.

Perhaps some mine superintendents are still on the fence as to whether a dispatcher will pay his way. He certainly has been and still is paying his way at the Adena (Ohio) mine of the Wheeling Township Coal Mining Co. This mine is a 100 per cent mechanical loading operation, working on a room-and-pillar system. For six months before the dispatcher was used a daily report was kept of delays, and it was found that 6.5 per cent of shift time was spent waiting for empties.

The dispatching system installed soon showed a nice saving by reducing car delays on the units from 6.5 per cent to 1.5 per cent of the shift time. Daily output was increased 120 tons, and this reflected a lower cost on all labor other than the cost of actually mining coal, which operation is on a straight tonnage basis. A direct saving of $22 per day was made on such labor as that required in mine maintenance, main haulage, and the tipple. In addition to this, an indirect saving of $11 per day was made on supervision, office, and mechanical maintenance labor.

Deducting from the above savings the wages of two dispatchers, there remains a net daily saving of $22.44. It would be rather difficult to say just what the intangible savings are, for any increase in production reflects a lower cost on the entire operation, not only in the operating cost but also in the fixed charges. A fair estimate of this, I believe, would be about $24 daily. This

Fig. 1—Dispatcher's Sheet for a Mechanized Operation

LOADS OUT — FACE NO.											EMPTIES IN				EMPTIES ON PASSWAY	TIME OF TRIP	WHERE FROM	LOADS		Empties Going In		Empties Left On Tipple	All Other Empties
Unit No.	Time Out	Delays	Unit No.	Time Out	Delays	Unit No.	Time Out	Delays	Unit No.	Time Out	Delays													
C S			C S			C S			C S									LOADS COAL	LOADS STONE	FACE			
Unit No.	Time Out	Delays	Unit No.	Time Out	Delays	Unit No.	Time Out	Delays	Unit No.	Time Out	Delays												MOTOR DELAYS
C S			C S			C S			C S														
Unit No.	Time Out	Delays	Unit No.	Time Out	Delays	Unit No.	Time Out	Delays	Unit No.	Time Out	Delays												TIPPLE DELAYS
C S			C S			C S			C S														
															DATE DISPATCHER			TOTALS					

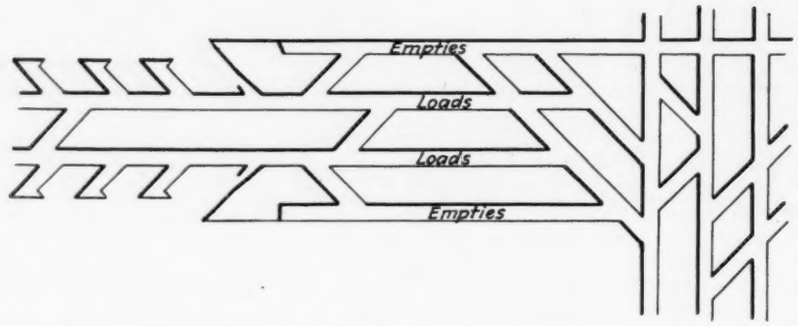


Fig. 2—Passway With Load and Empty Track for Each Loading Machine

sum added to $22.44 gives a total saving of $46.44 daily.

The dispatcher's office was placed on the outside, but could have been placed on the inside just as well. He is connected by phone to the several working sections and also to main points along the motor road and such places as the inside substation and inside repair shop, the total number of phones inside the mine being thirteen. With the aid of a switch, the dispatcher can connect any of these phones to any outside phone. The switchboard is not elaborate, but it takes care of the job without difficulty.

Fig. 1 shows the dispatcher sheet in use. This sheet plainly shows the entire performance of the shift. At first glance, the sheet may be thought highly complicated; one is inclined to think it is, but such is not the case. It has been divided so that units can be moved at will to any territory and the sheet adapted at once to the change. Each unit is provided with a space for recording cars of coal loaded (marked *C*) and cars of slate (marked *S*). In the same column, the time is marked when the unit brings the loads to the passway, and the dispatcher can tell about when the unit will be out with the next trip. The columns headed "Empties In" is provided so that the dispatcher can tell how many empties the units have at the face. This also greatly helps in foretelling just how soon they will need empties. The column headed "Empties on Passway" is nothing more than a check for the dispatcher on where the empties are and how many are available for each unit. The right-hand side of the sheet is arranged to show the movements of the main haulage locomotives and the balance of cars and their location.

At the end of the shift the complete story of the day's run is on one sheet in such concise form that one can tell at a glance the performance of each unit and each territory. One also can tell why units or territories were not up to standard, for each unit is provided with a column headed "Delays."

Information on delays is furnished by the unit motorman and the dispatcher uses it in fixing the time when the unit will be loading coal again. If the delay is caused by a mechanical failure, the dispatcher gets in touch with one of the face mechanics and the breakdown is therefore taken care of promptly.

The dispatcher's job is one of getting empties to the several loading units in such numbers that each unit may clean up a cut without delay while the motor is going to the passway for more cars. Some will say that it is almost impossible to arrange a system in which the loading machine is moving into a fresh cut while the motor is going to the passway with loads and returning with empties. They therefore advocate that empties be taken up to the loading machine by the main-haulage gathering motor. This extra work by the main-haulage gathering motor is not necessary with a dispatching system and passways placed at convenient points. The dispatcher can provide sufficient empties to clean up a cut, for he is always advised by the unit motorman as to how many cars will be needed to clean up the next cut. This system, therefore, enables the unit motor to pull loads to the passway and return with empties while the loading machine is moving from one room to the next.

In order to synchronize these movements, unit passways are located on the butt entries (see Fig. 2) and are so arranged that each unit has a loaded and an empty track. With this set-up, the unit motorman pulls his loads to the passway, then backs in against the empties, and pushes them up on his section. The only time this move causes a loading-machine delay is when the rooms at the head end of the butt entry are in only a short distance. Then the unit motorman must place his empties in several rooms and gather loads from other several rooms.

During the two years the system has been working, car delays have occurred, of course, but these were due chiefly to breakdowns of tipple and main haulage. The system has really turned out to be the pulse of the operation, for the dispatcher is in touch with all sections, all foremen, all mechanics, and all activity about the mine. If we had to try to operate without a dispatcher, conditions would be chaotic.

Coming: The Story of Crab Orchard

Few mining operations have had a more colorful history than the Eccles properties of the Crab Orchard Improvement Co. During the past two years, these mines, originally opened up by the Guggenheim interests in 1905, have entered a new stage of development.

Under the management of the Admiralty Coal Corporation, a joint undertaking of the Stonega Coke & Coal Co. and the Chicago, Wilmington & Franklin Coal Co., an intensive modernization campaign has been under way. Improvements have been made in practically every major phase of operation, with particular attention to safety, ventilation, blasting, underground transportation, pumping and preparation. Today these mines stand out among the leaders in the New River field.

When this modernization program was launched, arrangements were made to have the completed story told in *Coal Age*. Following out this plan, *Coal Age* editors visited these mines several weeks ago and made an intensive study of the objectives of the program, what had been done, and what has been accomplished. The results of this story will appear in a series of articles which will be published in the August issue.

WESTERNERS REVIEW

+ Technical and Economic Problems

In Rocky Mountain States

A WIDE RANGE of technical and operating problems confronting the industry in the Far West passed in review at the annual meeting of the Rocky Mountain Coal Mining Institute, held at the Hotel Utah, Salt Lake City, Utah, June 22-24. As in the past, safety questions were very much to the fore. Modernization was approached from the standpoints of financing, preparation, electrification and incentive payments on mechanical loading. The competition of natural gas and the place of the domestic stoker in stemming that onslaught formed the core of the economic discussion. Where cost accounting fits into the picture of progressive management and the advantages of mechanization in this field of endeavor also were on the program.

The bonus system instituted by the Union Pacific Coal Co. and outlined by I. N. Bayless, assistant general manager of the company, at the Cincinnati convention of the American Mining Congress (*Coal Age*, Vol. 37, p. 233), was reviewed in a paper by Mr. Bayless, read in his absence by D. C. Foote, mining engineer of the company. Rates and payments to the end of last year are summarized in Table I.

Interest has been stimulated by posting the sheets showing premiums earned, tons per man shift, etc. As the payment is on the two weeks' tonnage, remarked T. H. Butler, district superintendent, Union Pacific Coal Co., Rock Springs, Wyo., the men accept the breaking down of a machine as a necessary incident in operation against which they must contend. Premium checks are always paid to the man himself and never to his wife. They are regarded as his personal pin money.

"To foresighted moderns," said Walter M. Dake, consulting engineer, Joy Manufacturing Co., Franklin, Pa., "banks are depositaries, not instruments of torture. Bankers can be found that are favorable to coal negotiations calling for expenditures along well-planned modernization lines, nor are the equipment manufacturers averse to the extension of credit to those well-managed operations where the installation of their product will return a fair profit on the investment of the purchaser." In reply to H. C. Marchant, Pinnacle-Kemmerer Fuel Co., Denver, Colo., Mr. Dake cited the instance of an Illinois company which borrowed $175,000 for mechanization after two machines had been installed and had proved their ability to produce tonnage at low cost. Money, said Mr. Dake, can be obtained if profit on the investment is satisfactorily demonstrated.

T. H. Butler
Presided at meetings

Fullest possible use of old equipment should be made when equipment is installed to improve preparation practice, said R. W. Arms, Roberts & Schaefer Co., Chicago. Care should be taken not to make alterations to plant merely to accommodate temporary or intermittent demands, or a complicated mass of machinery will be installed, the maintenance and power requirements of which will be ruinous. Adoption of revolutionary methods will reduce obsolescence. To use proved methods eliminates some uncertainty, but it is likely to present the operator with a difficult obsolescence problem.

Some companies, asserted Mr. Arms, seem to thrive on revolutionary practice. An instance might be cited: A company in business for 64 years, 37 years of which has been under the present organization, has been stripping coal under somewhat adverse conditions. The seam is only 2 ft. thick, and the ratio of overburden to coal is 18 to 1. At least ten times during recent years it has adopted new and untried methods which later became accepted practice. Yet it has made a profit every year, and 1931 was the second best year since its reorganization.

It has always been recognized, he continued, that large raw coal bins are desirable because they regulate the feed, permit intermittent dumping and enable the preparation plant to run more hours than the mine, but they are costly and, because of segregation in the bin, they interfere with proper remixing of larger sizes with small. They also cause much breakage. Usually it is a difficult matter to decide whether regularity of feed is more to be desired than breakage is to be avoided.

Nut coal should be mechanically cleaned unless the cleaning process has as its purpose the removal of coal because of its appearance and not because of its impurity. The cleaning of egg coal by hand or by mechanical means usually is to be decided on the basis of relative costs of the two processes.

One must never forget the law of diminishing returns, cautioned Mr. Arms. Too much money easily can be spent to make a perfect technical product. So much may be spent for power when seeking excessive refinement in processing that the coal saved may not pay for the power used. In the Pocahontas region, the coal is rescreened often not to improve the product for the consumer but to assure the purchaser that the undersize of which he complains cannot be charged against the operator but is chargeable to degradation by the railroad or by the consumer.

Most of the operations shut down during 1930 and 1931 were mines without mechanical cleaning plants. The cleaning of the small sizes helps in moving coal not so cleaned, said Mr. Arms. Simplified cleaning practice will be one of the important products of the depression. Only those companies which prepare their coal in a strictly modern sense will continue to survive.

Accounting, stated J. J. Welch, chief accountant, Standard Coal Co., Salt Lake City, is no longer considered as merely a necessary burden of business; progressive managers and operating officials now regard it as a service, aiding closer and more effective supervision. Brief and condensed statements should be the real measure of the aid afforded. Accounting and clerical costs are material elements in expense and if the result of this expenditure does not point out condensed facts daily in understandable and readable form, something is wrong with the accounting department. If a remedy is not applied, the board of directors may take action.

Accounting systems should show whether the investment for machinery is paying for its cost. No income is too large if it can legitimately be obtained and no cost is low enough if it can legitimately be lowered.

Hand methods of accounting are startlingly inefficient as regards speed, accuracy and results, when compared with mechanical accounting methods accompanied with the proper division of labor. Office classification of work will prove just as effective as mine classification. The machines furnished must be those most suited to the work, for the work should not be vamped to fit any particular machine. Media once prepared and started, the machine operator can post on an average 135 individual accounts per hour. Despite several wage increases to accounting-machine operatives, the clerical expense is now less than 40 per cent of what it was with the old pen-and-ink system, and the economies effected pay for the mechanical equipment once every four months.

Gas companies have their troubles as difficult as those of coal operators, remarked J. R. Doolin, executive secretary, Utah Coal Producers' Association, Salt Lake City. The way to meet the competition of gas is by making the use of coal as automatic a service as that performed by gas. This can be done by the introduction of stokers. The difficulty is that no outside capital cares to go into the stoker business, because all the patents have expired and no assurance exists that rivals may not at any time cash in on the work and publicity of the company that has developed the business.

The producer, said Mr. Doolin, need have no fear that the stoker, by converting the consumer from a purchaser of domestic sizes to a purchaser of slack, would bankrupt the coal industry, for the price could be raised without surrender of the market to the gas companies. One of his neighbors had a gas bill of $30 a month. He himself burned in his stoker two tons of coal a month at $3.50 a ton, so his monthly bill was only $7.

With stokers, Utah coal can be burned without smoke unless an undue rate of combustion is demanded, and even then the smoke is merely gray, not black, and of short duration, declared Otto Duke, lecturer on mechanical engineering, University of Utah, Salt Lake City, in describing the work of the university in hand and mechanical firing of Utah coals, especially with the use of the Holland and Porter furnaces. The state had financed the experiments with a grant of $10,000, which had been duplicated by the Utah Coal Producers' Association. With hand furnaces, no matter the size of coal used, there was much of the blackest smoke every time coal was fired.

Objection had been made that the experiments were made under the most adverse conditions. Two pounds per square foot of grate area was consumption enough for domestic service. Mr. Duke had gone to consumptions as high as 18 lb. per square foot. One trouble was that the air pressures were so variant and erratic in mountain regions. D. H. Carrick, low-temperature coal distillation engineer, Salt Lake City, said that the Utah coals, as he had proved when with the U. S. Bureau of Mines, made much oil and a good gas running from 1,000 to 1,500 B.t.u.

Walter M. Dake

At a mine of the United States Fuel Co., said F. E. Gleason, general master mechanic of that company, Hiawatha, Utah, a 3-phase No. 0 copper 2,300-volt line 6,100 ft. long having an 80-per cent lag, supplied all power from a central outdoor substation to the mine. With a peak load of 900 kw. and an average load of 600 kw. the power loss was 145 kw. at peak load and 65 kw. on average load. Raising the voltage on this line to 11,000 volts, line losses were reduced to about 6 kw. on peak load and 2.6 kw. on average load. On a basis of $2 per horsepower, the change made a saving of $4,000 per year. This inefficiency arose from the increased power needed by mechanical mining.

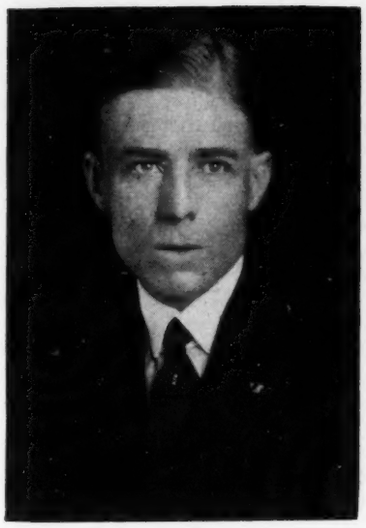
Two 50-lb. rails bonded have about the same electrical conductivity as a 1,000,000-c.m. feeder. With a larger feeder, the size of the rails must be increased or a return feeder added. With rock dust and moisture, the leakage of insulators carrying bare copper wire may be as much as 0.5 amp. per insulator on a 250-volt circuit. Assuming only 0.2 amp. per insulator, 100 insulators will have a 5-kw. loss, costing about $13 per month on peak and $4 on energy. Leakage of current from a conductor through moist rock dust causes rapid deterioration of copper, especially when gypsum dust is used.

Underloading or underspeeding of

Table I—Bonus Base Rates for Various Types of Equipment Established by Union Pacific Coal Co. With Bonuses Paid and Percentages Earning Them

Type of Loading Machine Used	Daily Output Fixed as Base	Premium Paid per Ton for All Coal Over Base Tonnage	Period of Observation	Percentage of Crews Earning Premium	Percentage of Tonnage Loaded by Premium Loaders of All Coal Loaded by Type of Loader	Tons per Man Shift Produced by Premium Loaders	Tons per Man Shift Produced by All Loaders	—Premium Earned— Total	—Premium Earned— Cents per Man-Shift
Shaking conveyor.....	15 T.P.M.S.*	25c.....	May 1-Dec. 31, 1930	33.0	39.9	18.2	14.0	$12,004.63	81.1
			1931†.....	56.6	67.3	....	15.9	31,142.49	82.2
Joy—Pioneer work....	250 T.P.L.S.‡	5c. to Dec. 1, 1930	June 1-Dec. 31, 1930	16.7	22.9	66.8	45.1	293.95	47.6
Joy—Top coal.....	300 T.P.L.S.	14c. thereafter....	1931.....	42.4	46.1	65.4	50.4	2,324.45	102.5
Joy—Pioneer and top	As above.	14c.....							
Pit-car loaders§.....	13.5 T.P.M.S.	28c.....	1931.....	33.3	24.8	14.3	11.3	230.16	22.3
Scraper loaders¶.....	20 T.P.M.S..	20c.....	May 16-Dec. 31, 1931.....	21.7	24.5	23.6	16.7	1,200.91	72.7

*T.P.M.S. = Tons Per Man Shift. †65 shakers in operation. ‡T.P.L.S. = Tons Per Loader Shift. §15 on an average. ¶Large scrapers.



Otto Herres
Presided at banquet

motors reduces efficiency. Motors are about 90 per cent efficient at full load and rated speed. A reduction in load of 25 per cent lowers efficiency about 2 per cent and a reduction of 50 per cent lowers it 5 per cent. Each reduction of 10 per cent below rated speed decreases efficiency about 8 per cent, especially with the older types of motor. Low voltage causes heat losses in addition.

Power is purchased by the United States Fuel Co. on 5-minute peak demand with an energy charge and discount allowance for load factors. To lower peak loads, one might avail oneself of dispatching of trips, but, as the fuel company meters all its power at a centrally located station and the mines are a long way apart, that system is impracticable, so the power is cut automatically from one or more mechanical loading districts. No interruption lasts more than 4 minutes. Wattmeter charts show that an outage of 0.05 per cent of the total loading time of the mechanical units will save over 10 per cent of the total power cost.

Among losses may be cited: Carelessness in turning out lights (power consumption of a 100-watt light globe will cost 27c. if left on during 5 minutes of maximum demand); locomotive operation with brakes partly set; tight gage of haulage tracks, especially on curves; insufficient or faulty lubrication; unnecessary operation of equipment, such as shop machinery and air compressors and pumping during times of peak requirement.

Gypsum dust caused much trouble in New Mexico, declared L. M. Koontz, Mine Safety Appliances Co., Salt Lake City. For this reason, all the conductors except the trolley wire were insulated. The trolley did not give much trouble, because the trolley wheel cleaned the wire as it traveled along it.

High alternating-current voltage was recommended by F. A. Rank, industrial engineer, General Electric Co., Salt Lake City. Utah State laws did not permit a pressure of over 400 volts underground, but Mr. Rank did not believe higher voltages dangerous if the conductor was lead-covered, armored and properly grounded, as the Utah Industrial Commission's safety rules required. Only one company had a 4,000-volt line. Grounds should not be more than 1,000 ft. apart. Shooting, or No. 14, wire is often used; but No. 4 or No. 2, with all connections tight, should take its place.

Insufficient space was often provided behind the switchboards, making it dangerous and difficult to work. In case of trouble the set must be out of commission much longer than if adequate room were provided. In small rooms, transformers and motor-generators get hot and cannot carry the load as well and safely as if provided with correct ventilation. Space will pay dividends. Low-voltage distribution lines are more easily tapped for branches, and nips are more readily made for operating equipment, but the open nip is dangerous, and Mr. Rank favors higher voltage because he believes it safer, the men treating it with more respect. At branch circuits, there should always be a disconnecting switch and fuses of adequate size. These switches, if inclosed, would give a large increase of safety for little extra expense.

New Officers Elected

L. R. Weber, Liberty Fuel Co., Salt Lake City, Utah, was elected president of the Rocky Mountain Coal Mining Institute for 1932-33 at the Salt Lake City meeting last month. J. A. McFadden, Boulder Valley Coal Co., Erie, Colo., was chosen vice-president for Colorado; Allan French, St. Louis, Rocky Mountain & Pacific Co., Raton, N. M., vice-president for New Mexico; W. H. Woodhead, Independent Coal & Coke Co., Kenilworth, Utah, vice-president for Utah; and Harry L. Gandy, Sheridan-Wyoming Coal Co., Kleenburn, Wyo., vice-president for Wyoming. H. C. Marchant, Pinnacle-Kemmerer Fuel Co., Denver, was relected secretary and treasurer.

The new executive committee has the following membership: Robert Williams, Calumet Fuel Co., Somerset, Colo.; James S. Veatch, Ohio Brass Co., Denver, Colo.; Thomas Husband, Gallup-American Coal Co., Gamerco, N. M.; Scott Dupont, Phelps Dodge Corporation, Dawson, N. M.; J. Taylor, state mine inspector, Price, Utah; O. J. Nesslage, Sullivan Machinery Co., Salt Lake City, Utah; R. R. Knill, Union Pacific Coal Co., Rock Springs, Wyo.; and P. H. Burnell, Owl Creek Coal Co., Gebo, Wyo.

Looking merely at the financial side of safety, Mr. Rank would favor better electrical installation. Compensation for a life in the past three years has cost in Utah $3,891, an increase of 15½ per cent over the previous eleven years. Capitalizing a life a year at 7 per cent, the expenditure that might profitably be made to eliminate the risk could be $55,000. Adding incidental losses, perhaps $100,000 could be spent to avoid merely the financial loss. From $2,000,000 to $4,000,000 could be spent by the industry to cut fatalities due directly to electricity 25 to 50 per cent. If explosions caused by electricity are considered, the sum would mount to many more millions. Delays due to faulty installation cause immense losses, as also do maintenance and inspection.

One company in the Rocky Mountain region during 1914 could not keep men on their cutting machines, said William Moorhead, superintendent, Calumet Fuel Co., Delcarbon, Colo., in a paper read by D. J. Parker, U. S. Bureau of Mines, Salt Lake City. They complained of the effect of dust in their lungs. The doctor ordered them to quit, and it was difficult to get good men. So the company installed a cutter-bar sprinkling system and now it is almost universally applied in the region, not only to protect men's lungs but as a safety measure.

Where traveling ways were driven through the outcrops, much adobe was deposited on the floors. Mules and men stirred this up, and the air carrying it forward deposited it through the traveling ways for some distance. Later it was dug from surface banks and screened from the roads and deposited in the mines, rendering them relatively immune from explosions.

Many years ago the Union Pacific Coal Co. used adobe in this manner, declared Mr. Butler, but he preferred rock dust. He liked its illuminating qualities. Where rock dust is used, one can readily note undusted areas by the darkness of such sections.

Over a ten-year period, said Gordon MacVean, Mine Safety Appliances Co., Salt Lake City, coal-mine accidents cost for compensation alone about 5c. per ton, to which may be added another 5 per cent for medical and hospitalization costs. On an average, throughout the country, non-fatal accidents have cost about twice as much as fatal accidents, being about equally divided between permanent and temporary disability.

Table II—Comparative Fatality Rates

States	Fatality Rates Per Million Tons 1930	1931	Rate of Improvement Per Cent	No. of Injuries Per Fatality, 1930
Average, United States	3.84	3.27	15	43.99
Wyoming	3.78	2.80	26	40.74
Utah	13.15	3.63	72	15.91
Colorado	4.27	3.41	20	40.66
New Mexico	7.62	3.95	48	22.07

The figures in Table II show how the Rocky Mountain States stand.

It will be noted that in Utah and New Mexico, where the fatality rate is high, the proportion of injuries per fatality is quite low. In fact, the ratio for the group is 32 per cent less than that for the United States as a whole. Systematic timbering probably is one of the most important steps to be taken in furthering safety.

New credit items on protective clothing totaling 18c. per $100 of payroll have been issued by the Pennsylvania Compensation Rating and Inspection Bureau. During the 5-year period 1926-1930, head injuries in Pennsylvania mines totaled 7 per cent of all compensation cost; eye injuries, 5.7 per cent; and foot injuries, 2.6 per cent. Had all the persons injured during these five years been wearing protective hats, goggles and safety shoes, 15.3 per cent of all compensation insurance cost in insured bituminous mines of Pennsylvania could have been saved. An 8c. credit is provided for the protective hat and 5c. each for safety shoes and goggles.

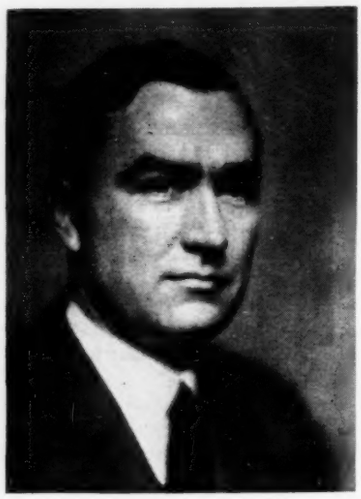
Electric lamps now give 55 cp. instead of 2 cp. as formerly, and the illumination they afford protects the mine worker against natural hazards and machinery. The U. S. Bureau of Mines is studying the relation of illumination to safety and finding it an important factor. All Utah mines use electric lamps; about 95 per cent of Colorado miners; 90 per cent of New Mexican miners; and 80 per cent of the miners in Wyoming. In 1920 there were about 125,000 in use in the United States. Now there are 280,000 or more.

There are now three types of direct-reading methane indicators correct to 0.1 per cent. Only about 25 per cent of all mines in this country use rock dust. Practically all state mining laws mention the advisability of the use of rock dust with one outstanding exception, and all three major catastrophes thus far in 1932 have occurred in that state. About 20,000 self-rescuers are in use to ward against the 50 per cent of fatalities after mine explosions resultant from afterdamp, carbon monoxide and smoke.

Systematic timbering appealed to R. D. Hall, engineering editor, *Coal Age*, as an excellent means of decreasing accidents, but, he added, safety will never be attained till safety posts and straps are added to carry support across the traveling lane in front of the face. Europe uses a large number of such posts, not merely one to a place, and spreads the protection by the use of long steel corrugated crosspieces or straps. The United States needs the straps the more because of space required for maneuvring its heavy machinery.

Mr. Butler said the Union Pacific Coal Co. used the Sylvester prop puller for post removal. Mines should be sectionalized, said V. O. Murray, if responsibility is to be localized and safety obtained.

As one comes west, declared R. W. Gillespie, president, Jeffrey Manufacturing Co., the atmosphere of the depression seems to lighten. New York bankers have lines laid all over the country to keep in touch with trade movements, and because they are so busy attending to other people's business and misfortunes, they have no time to attend to their own. If everyone studies his own situation, he will improve his own financial position, and the general financial situation will be improved.



R. W. Gillespie

State mine inspectors have not only saved the lives of miners but in many cases have saved operators from bankruptcy, declared R. R. Vail, inspector, Employers' Mutual Insurance Co., Denver, Colo. Bad roads not only cause accidents but are the cause of loss of material, heavy power bills and wrecks. Spilled coal is loaded on roadsides, where it falls back on the road, and into crosscuts, whence it has ultimately to be removed in order to rebuild brattices and stoppings. Thus is the road coal shifted back and forth. One foreman recently told him he was trying "to wear the coal dirt out." Wrecks or breakdowns lay the entire company crew idle and are a heavy operating cost.

Discipline is badly needed. Too many are satisfied to tell the miner when they visit his place what he must do. They should have him disciplined to do what is needed, so that the foreman, when he visits, will find it done. If the man waits for the foreman to tell him what to do he may be carried out on a stretcher. Once told, if the condition is found on the next visit, the foreman will know it is carelessness or ignorance, neither of which qualities belongs in a coal mine. Penalizing a miner after he is hurt is useless. Halving compensation for carelessness serves to little purpose. Layoff or discharge is the real remedy. Avoid too many and questionable rules. They spoil discipline. By establishing discipline on the old rules first, better results are obtained. Men must be instructed in safety in all mines before safety will be assumed, for they drift around so much that no one can have a safe mine if he accepts men from mines without safety discipline.

If screen goggles are used, have them made with, say, fourteen wires to the inch. The coal particles that will go through such a mesh will not injure the eye seriously. A wide mesh and the wires coated with a light, not shining, non-corrosive metal will give good visibility. The first goggles supplied had 24 wires to the inch and were painted black. They absorbed too much light. Glasses with side flaps, steam and are undesirable.

Why should not two, three or more small companies combine to engage a full-time safety engineer to attend to their safety needs, paying him on a tonnage or some other basis dependent on physical conditions, inquired, in a paper, D. K. Wilson, deputy inspector, Rock Springs, Wyo., just as companies have combined in the past to participate in the services of a mine-rescue force or of a surveying staff?

At the close of the meeting, Mr. Parker presented the Joseph A. Holmes Safety Association awards to:

United States Fuel Co., Salt Lake City, Utah—For producing 1,100,000 tons of coal without fatality at three mines, largely in extraction of pillars. In 1931 more than 546,000 tons was mined by about 500 men with no fatalities and only 28 lost-time accidents.

Liberty Fuel Co., Latuda, Utah (Liberty Mine)—For producing 1,018,000 tons of coal from Dec. 8, 1925, to Dec. 8, 1930, without a fatality with an average of 102 employees working 1,097,016 man-hours.

Calumet Fuel Co., Somerset, Colo. (Somerset Mine)—For producing 1,750,000 tons of coal from a gassy, inclined, thick coal bed under exceptionally heavy cover, without a fatality from March 20, 1923, to Dec. 31, 1931, or over 8¾ years, working 2,500,000 man-hours.

Sheridan Wyoming Coal Co., Kleenburn, Wyo. (Monarch Mine No. 45)—For operating without a fatality from Dec. 2, 1924, to Dec. 31, 1931, or over seven years, producing 2,345,001 tons of coal from 1925 to 1931, inclusive, and for producing 257,007 tons in 1931, with but seven compensable accidents.

Hotchkiss Coal Co., Dietz, Wyo. (Hotchkiss Mine)—For producing 672,107 tons of coal from April, 1920, to Dec. 31, 1931, or over eleven years, without a fatality. For producing 30,826 tons in 1931 with but one compensable accident.

LARGER LOADS DEVELOP

+ Higher Over-all Efficiency

In Fast Mine-Hoist Duty Cycles

By H. W. CHADBOURNE

Industrial Engineering Department
General Electric Co.
Schenectady, N. Y.

and CARL LEE

Electrical Engineer
Peabody Coal Co.
Chicago

THE quantity of coal which can be produced from a given mine is often limited by the size of cars which can be used in the haulageways and rooms. There is a tendency today to use cars built low so as to carry a greater volume of load and yet not be either higher or wider than the former cars. As only one car usually is hoisted at a time on a cage, if the load is light and the tonnage large, it requires the hoisting of a large number of trips per day. On the other hand, if larger loads can be hauled and hoisted, the number of trips to obtain a certain tonnage will be reduced. This can always be done with smaller electric equipment, usually with better over-all efficiency.

A striking example of this is given by the equipment at mine No. 53 of the Peabody Coal Co., near Springfield, Ill. The electric equipment consists of a direct-current hoist motor rated 850 hp. at 116 r.p.m., taking power from a synchronous motor-generator set and operating on the Ward Leonard or generator-voltage-control system. The output required is 320 tons per hour from a depth of 284 ft. Coal per car is 2,800 lb., or 1.4 tons. This means 230 trips per hour, or 15.65 seconds per trip. This is divided as follows: acceleration, 5 seconds; full speed running, 1.65 seconds; retardation, 5 seconds; rest or dumping time, 4 seconds. This is very rapid operation and a large quantity of power is wasted in accelerating and retarding the load and equipment. The drum chosen is of the cylindro-conical type, 5 ft. small diameter, 9 ft. large diameter, and with 3.2 turns on the cone. The WR^2 of the drums and sheaves is 375,000 lb.ft.^{2} Fig. 1 shows this duty cycle. The over-all efficiency, not considering power factor, is 26.3 per cent, and the kilowatt-hour per trip is 0.8. The rope speed is shown in Fig. 2. The cage is always being accelerated or retarded.

This equipment has operated successfully for several years. In fact, at one time it operated for one-half hour at the rate of 288 trips per hour, or a trip in 12.5 seconds. This was accomplished by decreasing the rest period and increasing the generator voltage. The rates of acceleration and retardation were so high, however, that an operator could not handle the hoist for a long period of time.

Recently the question of increasing the load per car was considered. The weight of the car was to be increased from 2,100 lb. to 2,400 lb. and the load per car from 2,800 to 4,000 lb. To hoist the same tonnage per hour, the number of trips would be reduced from 230 to 161. Using the turns on the drum as before—that is, 4.84 turns on the small cylinder, 3.2 turns on the cone and 4.84 turns on the large cylinder—gives a drum speed of 58 r.p.m. and a calculated horsepower of 250. Fig. 3 shows the duty cycle and Fig. 4 shows the rope speed. The kilowatt-hours per trip are 1.08 and the over-all efficiency is 39.7 per cent.

The speed of a separately excited, direct-current motor with constant field strength varies directly as the applied voltage. To obtain half speed, the volts must be cut in half and this will give one-half horsepower at full-load current. The horsepower required, as shown above, is well below one-half of normal and, therefore, the motor would operate under this condition without overheating. The only possibility of overheating would be in the motor shunt fields. These carry the same current as before but with less windage. This could be overcome by reducing the field current 5 or 10 per cent and increasing the armature voltage to offset this change.

In view of the above, calculations were made to ascertain the maximum tonnage that could be hoisted with this equipment. From these calculations the curves in Fig. 5 were drawn. First the point at 850 hp. and 116 r.p.m. was plotted, then a straight line drawn to the zero point. This line shows the horsepower at any speed to give normal

Fig. 1—Duty Cycle, 2,800 Lb. of Coal per Car

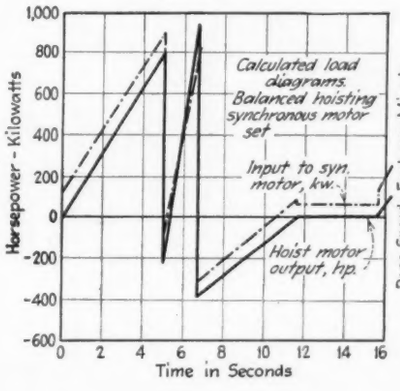
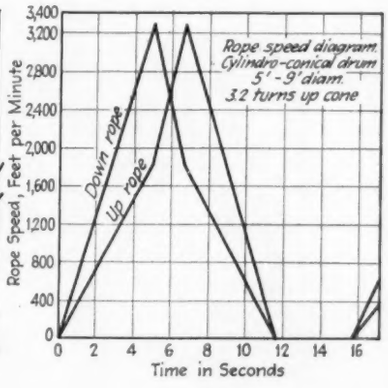


Fig. 2—Rope Speed, 2,800 Lb. of Coal per Car



current on the motor. As long as the horsepower curve is below this line the motor will do the work without overheating. Calculations were made at a number of speeds and the horsepower speed curve was plotted. This curve crosses the normal current line at about 111 r.p.m. At 116 r.p.m., with the increased load the required horsepower was only 900. This gives the surprising result of obtaining 43 per cent more coal with only 6 per cent more horsepower. A curve of tons per hour against speed also is given.

In view of the above, the 4,000-lb. load cycle at 116 r.p.m. was completely analyzed. As the calculations were made by the system of moments, the curves given in Figs. 6 and 7 are plotted moments against turns of the drum. Fig. 6 shows the load moments for the 2,800-lb. load and for 4,000-lb. load, also the final moments for the 4,000-lb. load. In studying Fig. 7 it will be noted that, because of the drum shape, the moment curve, down car and cage, has a large negative value during acceleration. This means that the net moments, not including accelerating and retarding moments, are negative at this time. These curves also show that the greater part of the power used is for acceleration and retardation. As the load is a small part of the total moving mass, a change has small effect on results.

The power required for acceleration and retardation varies as the square of the rate of acceleration or retardation. At 116 r.p.m. the rates of acceleration of the up-load, in feet per second per second, are as follows: on small cylinder, 6.12; up the cone, 14.8; and the retardation on the large cylinder, 11. The changes in speed for the down-going cage are the reverse of the above. These rates are very high and are approaching the limits for practical operation,

both from the standpoint of power consumed and of the ability of the operator to control the trip accurately.

The over-all efficiency of the equipment when hoisting a 2,800-lb. load at 116 r.p.m. is 26.3 per cent. For a 4,000-lb. load at the same speed it is 44 per cent. The maximum efficiency is 46 per cent, which comes at 80 r.p.m.; below that point it falls off and at 40 r.p.m. is 39 per cent. The reasons for the change in efficiency are as follows: With high-speed operation a large percentage of the power is used in acceleration and retardation, but the machines are operating at high efficiency. At 80 r.p.m., the accelerating and load moments are more nearly equal with the machines still operating high enough on the load curve to have very good efficiency. At 40 r.p.m., the machine efficiencies, especially those of the synchronous motor, are very low. At this speed an induction motor-driven hoist would have an over-all efficiency of 58 per cent, and at 58 r.p.m. its efficiency would be 54 per cent. At 90 r.p.m., the efficiency of an induction motor equipment is practically the same as the direct-current equipment, but the motor would be rated 700 hp. This, however, has a rate of retardation too high for an induction motor.

From the foregoing it can be seen that it is desirable to hoist the largest load which can be handled in the mine, the larger load giving better efficiency, either at the same speed or a lower speed to obtain the same tonnage. For the same tonnage the electric equipment will be smaller and often it will be possible to use an induction motor equipment instead of a direct-current Ward Leonard equipment. In any case the first cost of the electric equipment and the kilowatt-hours per ton hoisted would be reduced.

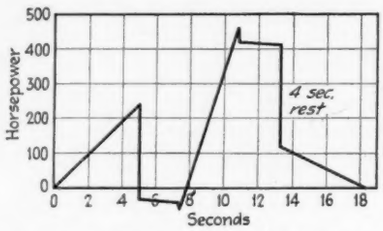


Fig. 3—Duty Cycle, 4,000 Lb. of Coal per Car

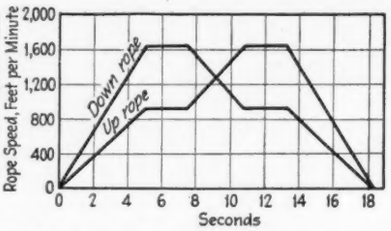


Fig. 4—Rope Speed, 4,000 Lb. of Coal per Car

Fig. 5—Horsepower and Speed for Constant Current

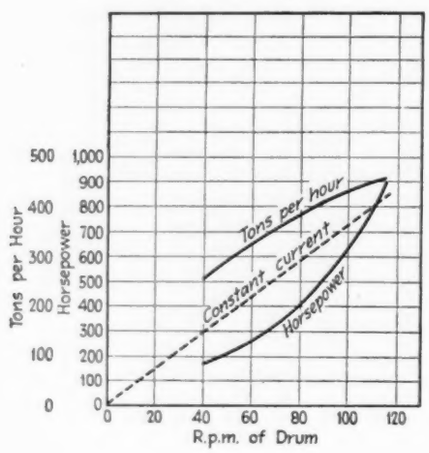


Fig. 6—Load Moments, 2,800 and 4,000 Lb.

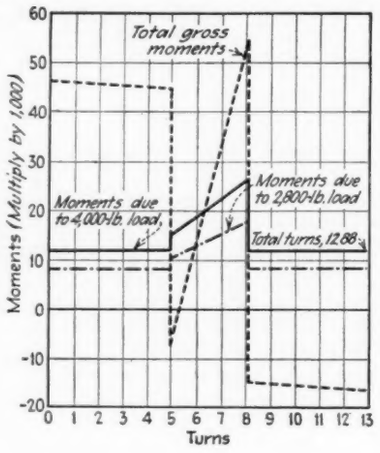
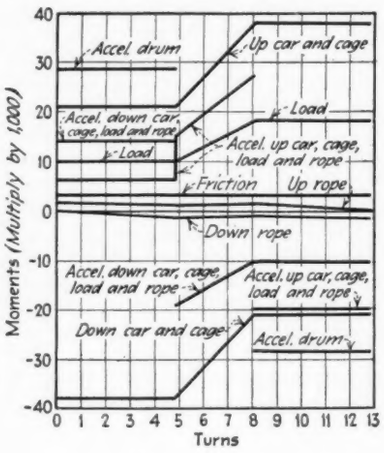


Fig. 7—Graphic Analysis, Hoisting Moments



NOVA SCOTIA INSTITUTE

+ Discusses Modernization Problems

Officials of Mining Society of Nova Scotia for Ensuing Year:

President—John C. Nicholson, general superintendent of coal mines, Dominion Steel & Coal Corporation, Glace Bay, N. S.

First Vice-President — John P. Messervey, deputy inspector of mines, Halifax, N. S.

Second Vice-President — Alex L. Hay, assistant mining engineer, Dominion Coal Co., Glace Bay, N. S.

Secretary-Treasurer — Sidney C. Mifflen, office engineer, Dominion Coal Co., Glace Bay, N. S.

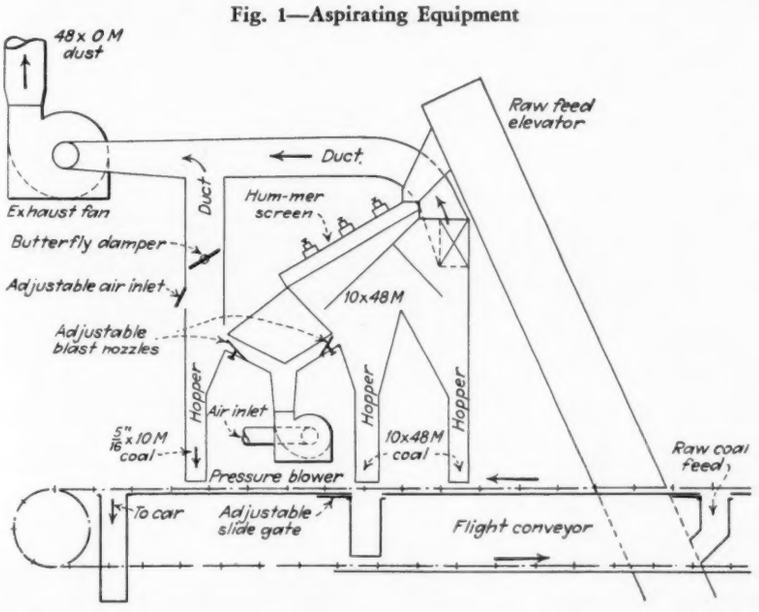
MODERN practice in mechanical coal mining and preparation on both sides of the international boundary line furnished the theme for the Fortieth Annual Meeting of the Mining Society of Nova Scotia, held at Baddeck, N. S., June 28-29. Papers and discussion dealing with a wide range of mining problems from cutting through conveyor mining and steel timbering to the de-dusting of stoker coal were presented by mining men of Canada and the United States.

De-dusting, or aspiration, methods used in preparing stoker coal at the New Orient mine of the Chicago, Wilmington & Franklin Coal Co. were described by H. B. Cooley, vice-president, Allen & Garcia Co., Chicago, in a paper on "Present-Day Tendencies in the Design and Operation of Coal Preparation Plants," read, in the absence of the author, by Karl H. Marsh, chief engineer, Dominion Steel & Coal Corporation. The increasing popularity of the underfeed stoker for domestic and semi-industrial use, he said, brought the coal company's sales department face to face with the problem of producing a satisfactory coal for this equipment. As the underfeed stoker is best suited for strongly coking coals with a high fusion point, preparation modifications were necessary to make the free-burning Middle-Western coal suitable. Fuel tests showed that coal with a high percentage of fines increased draft resistance and caused holes to appear in the fuel bed, with consequent inefficiency in combustion.

To overcome these objections, de-dusting experiments were conducted, and, as a result of extensive combustion tests, two products were decided upon. For domestic stokers, it was found that ⅜-in. x 10-mesh coal gave best results from the standpoint of efficiency and as a "dustless" fuel to compete with coke, oil and gas. Tests on coal for commercial stokers indicated the desirability of retaining some of the 10x48-mesh material, and the standard was set at ⅜ in. x 10 mesh, with 50 per cent of the 10x48-mesh size added and as much as possible of the minus 48-mesh material removed.

The aspirating equipment adopted is shown diagrammatically in Fig. 1. Minus ⅜-in. coal is passed over a Hummer vibrating screen equipped with a screen mesh with a free opening of 0.08 in. The screen angle is adjustable, and is at present set at 35 deg. As the moisture in the coal is not high (approximately 9 per cent), the screen gives a preliminary separating between the fines and the plus ½-in. material. Both the oversize and undersize cascade past air gaps fed from a pressure blower. Nozzles are adjustable; at present the oversize passes an opening 12 in. long and ⅛ in. deep, while the undersize passes an opening 24 in. long and ⅛ in. deep.

Fig. 1—Aspirating Equipment



The air jets tend to drive the fines out horizontally to a point where they come under the influence of an exhaust fan, which draws them out of the system. Dust from the undersize, in traveling to the exhaust fan, passes over two hoppers where the velocity is reduced, permitting any of the larger particles to be deposited. Size of the dust from the oversize is controlled by adjusting the butterfly damper and the air inlet in the fan duct. For making the various sizes required by the market, a mixing slide gate is inserted in the 10x48-mesh hopper to enable the operative to mix the ⅜ in. x 10-mesh and 10x48-mesh, using any proportion of the latter.

Average results of screen tests, using standard testing sieves with screen openings decreasing in a ratio of $\sqrt{2} = 1.414$, are given in Table II, page 272. To provide as nearly as possible a fuel meeting certain definite specifications, the company's combustion engineers drew up theoretical screening curves, requesting the operating department to

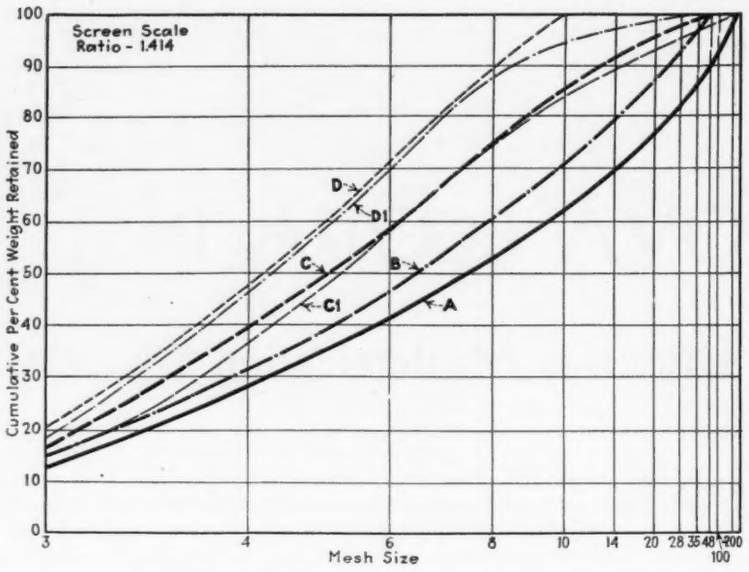


Fig. 2—Comparison of Theoretical and Practical Results

(A) Cumulative screen size percentages, raw $\frac{1}{4}$x0-in. coal from table. *(B)* Theoretical screen size percentages, $\frac{1}{4}$ in. x 48-mesh coal. *(C)* Standard curve, $\frac{1}{4}$ in. x 10-mesh plus 10x48-mesh arranged with decreasing percentages of sizes from 10- to 48-mesh, the average of these sizes being 50 per cent. *(C1)* Cumulative screen size percentages, shipped $\frac{1}{4}$ in. x 10-mesh plus 50 per cent of 10x48-mesh. *(D)* Standard curve, $\frac{1}{4}$ in. x 10-mesh. *(D1)* Results on $\frac{1}{4}$ in. x 10-mesh.

make its product conform as near as possible. The success attained is shown in Fig. 2.

Curves *C1* and *D1* give evidence that a certain quantity of fines is carried over with the aspirated coal, while some coarse material, due to the influence of moisture in the coal, relative humidity of the air, and the shape of the particles, goes into the dust. Experiments are now under way to insure that the relatively large percentage of thin, lightweight, laminated particles which give the most trouble by going into the dust will be deposited in the proper screening fraction. Use of the aspirating system, Mr. Cooley declared, gives more positive control of the 10x48-mesh size, which was not possible with equipment which did not include the vibrating screen and pressure blower.

In most Nova Scotia mines, compressed air must be used for the operation of coal cutters, said A. F. Cagney, director of Peacock Brothers, Montreal, in discussing some elements of the design of coal cutters contributing to better performance. The cost of this form of power, he remarked, was unduly high, and means for reducing this cost demanded more than perfunctory interest. There are instances where the consumption of compressed air per ton of coal is 2,500 cu.ft. and where the pressure at the face is sometimes not more than 50 per cent of the initial pressure.

Average energy taken by electric coal cutters Mr. Cagney declared to be 0.4 to 0.5 kw.-hr. per square yard undercut; consumption varies from 0.2 kw.-hr. in very free cutting material to about 1.0 kw.-hr. in the hardest coal, the consumption being directly affected by the tension of the chain, its construction and the condition of the cutter bits. In many instances, the removal of a few bits and a realignment of the others will not reduce the cutting time appreciably but will show quite a marked improvement in the quantity of round coal obtained from the holings. Superfluous picks merely churn the cuttings.

Notable progress in modernization by the Dominion Coal Co. was outlined by A. S. MacNeil, district superintendent, and Joseph Kalbhenn, ventilation engineer, Glace Bay, N. S. Shaking conveyors were first introduced by the company in 1923. Originally side driven with single-acting engines, the drive was later placed underneath and double-acting engines were used, with greatly improved results. It was soon found that a shaking conveyor on a level had a capacity only 30 per cent of that of a similar unit bringing coal down a 20-per cent gradient.

Later a 24-in. conveyor belt was installed at Dominion No. 12 to receive coal from side conveyors. The coal was delivered to the belt from a 250-ft. face down a 20-per cent dip by a shaking conveyor, and from a 50-ft. face up a 20-per cent rise by a flight conveyor. Results were so good that the 250-ft. face was extended to 450 ft., making a 500-ft. face. Undercuts, which were 4½ ft. deep, were increased to 6 ft. The belt also was replaced by one 30 in. wide.

Where coal has to be brought up the main slopes a sectional chain conveyor, also air-driven, is used with success. Troughs and chains are in 6-ft. lengths. Coal pillars proved so inadequate under the tremendous weight that a 250-ft. longwall face was driven and the two main slopes were located in the gob, the coal from the longwall face being brought to the conveyor by shaker conveyors.

In Dominion No. 10, the roof weight being less and the gradient 9 per cent, the coal is mined on retreat, roadways being in the solid coal with 300-ft. faces on either side with a shaker conveyor to the rise and a 20-in. flat-belt conveyor to the dip. Experiments are being made with the Jigger Digger. Time studies and sectionalization of costs are used to promote economy.

No longer are packwalls used solely along the gates for their protection. Midwalls, 9 to 12 ft. wide, are erected in the gob at intervals averaging 40 ft. Two rows of hardwood chocks with 6x6-in. timber 24 to 34 in. long are set behind the face with steel chock releasers, making it possible to collapse the chock by a blow of a sledge. Sometimes composite steel props with corrugated steel straps (caps) are used, and then, occasionally, the midwalls can be eliminated. In Dominion No. 16, for faces from 50 to 80 ft. long with

(Turn to page 275)

Table I—Screen Test, Raw Coal

Mesh	Size Per Cent	Ash, Per Cent	Ash Cumulative Per Cent
$\frac{1}{4}$ in. x 10	57.79	7.75	7.75
10 x 20	15.24	8.03	7.80
20 x 48	14.45	12.38	8.57
48 x 100	4.92	14.42	8.90
100 x 200	2.15	14.90	9.00
— 200	5.47	15.00	9.34

Table II—Results of Screen Tests on Raw and Aspirated Coal, and Dust

		Raw Coal ($\frac{1}{4}$ x 0-in.)		Aspirated Coal ($\frac{1}{4}$ in. x 10M)		Aspirated Coal $\frac{1}{4}$ in. x 10M Plus 50 per cent 10 x 48M)		Dust	
Size, In.	Mesh	Per Cent	Cumulative Per Cent	Per Cent	Cumulative Per Cent	Per Cent	Cumulative Per Cent	Per Cent	Cumulative Per Cent
0.441	.....	000.00	.....	.....	.....	.....	.....	.....	.....
0.371	.....	Trace	.....	.....	.....	.....	.....	.....	.....
0.312	2.5	0.71	.....	1.32	1.32	1.27	1.27	.....	.....
0.263	3.0	3.52	4.23	3.92	5.24	3.37	4.64	.....	.....
0.221	.....	.....	.....	.....	.....	.....	.....	.....	.....
0.185	4.0	15.29	19.52	25.17	30.41	19.33	23.97	.....	.....
0.131	6.0	14.75	34.27	27.69	58.10	23.37	47.34	.....	.....
0.093	8.0	12.95	47.22	22.71	80.81	21.44	67.78	0.08	0.08
0.065	10.0	10.57	57.79	11.01	91.82	11.90	80.68	0.46	0.54
0.046	14.0	8.05	65.84	4.03	95.85	6.75	87.43	1.42	1.96
0.033	20.0	7.19	73.03	1.72	97.57	4.13	91.56	3.51	5.47
0.023	28.0	5.85	78.88	0.91	98.48	2.86	94.42	6.05	11.52
0.016	35.0	4.83	83.71	0.55	99.03	1.99	96.41	9.40	20.92
0.012	48.0	3.75	87.46	0.29	99.32	1.17	97.58	9.91	30.83
0.0082	65.0	2.92	90.38	0.21	99.53	0.93	98.51	11.71	42.54
0.0058	100.0	2.00	92.38	0.11	99.64	0.54	99.05	12.33	54.87
0.0041	150.0	1.26	93.64	0.06	99.70	0.30	99.35	9.96	64.83
0.0029	200.0	0.89	94.53	0.06	99.76	0.17	99.52	9.17	74.00
—0.0029	—200.0	5.47	100.00	0.24	100.00	0.48	100.00	26.00	100.00

POWER TRANSMISSION

+ In Coal Preparation Plants

CONSIDERATION of the problem of transmitting power in coal preparation plants must bear largely on the character of the load and on installation requirements. Coal preparation equipment, in general, is called upon to handle large quantities of material at relatively low speeds. Arrangement of equipment is so regulated, as a rule, that the coal pursues a downward path from the dump to the railroad car, thus eliminating all but a necessary minimum of elevating. To get the coal into the car, the horizontal flow of material must be changed at least once in the majority of plants. Problems of arrangement, therefore, in connection with the often unfavorable character of the ground on which the plant must be built, frequently make the disposition of driving motors and power transmission equipment difficult. As a result, power transmission equipment in coal preparation plants must not only be adaptable to the installation where space is limited but also must be able to operate heavy equipment over long periods of time without breakdowns.

Modern operating practice in coal preparation plants is based on the use of individual motor drives. Practically all types of power-transmission equipment are in use—some more than others—but the majority installed in preparation plants today falls into only three or four classes, as set forth in the accompanying table. This table represents the *average* present-day practice only, and was compiled by *Coal Age* from reports on a number of new plants installed in the past three years, supplemented by information furnished by manufacturing and engineering companies engaged in the design and erection of plants.

It should be noted that practice outlined in the table is only that at present in general use. For instance, there are other than reciprocating plate feeders installed in plants today, but the plate feeder is well in the lead, and for this reason is included in the table as the average practice today. Similarly, there are motors in use which are both larger and smaller than those listed for feeder service, but as these are in the minority, they were not included as representing present average installation conditions.

Because, with few exceptions, the speed of the driven shaft of the equipment is much less than that of the driving shaft of the motor, power transmission equipment serves not only to transmit power but also, in general, to reduce the speed. The usual motor speed, as shown by the survey, is either 900 or 1,200 r.p.m., with the present tendency toward the latter or even higher speeds. Reductions in speed necessarily are accomplished by the use of a pulley or pinion of minimum practical diameter (which should not be less than that specified by the manufacturers) on the motor shaft, and a larger pulley or pinion on the driven shaft. Interposed there may be a gear train, belt, speed reducer, etc., or a combination of two or more types of equipment.

As shown in the accompanying tabulation, belts of various types in combination with pulleys, combinations of belts and spur gears, and speed reducers are most generally employed for speed reduction in preparation plants. With a belt, the power transmitted is proportional to the difference between the tight-side tension and the slack-side tension. This difference is the effective belt tension, which also may be described as the amount of tightness in the belt required to provide the traction or grip on the pulley to enable the belt to carry its load. Efficiency of a belt drive is determined by this tension and the coefficient of friction of the belt on the pulley. The higher the coefficient of friction, the less the tension required; the lower the coefficient of friction, the higher the tension required. With a given coefficient of friction and belt tension, the belt is made wide enough to withstand the tension over the longest possible period of useful life. The above contemplates operation of the belt at a reasonable speed. Where the linear speed of the belt exceeds approximately 4,500-5,000 ft. per minute, it has been found that, unless special automatic tensioning equipment is used, belts are drawn away from the pulleys by centrifugal force. Excessive slip results; the efficiency of power transmission is lowered.

With flat belts, according to most authorities, the diameter of the driving and driven pulley and the center-to-center distance should be in such a relation that the arc of contact on the smaller pulley, with the exception of certain specially designed belts, is not less than 165 deg. The usual type of flat belt can operate with a smaller arc, but experience has shown that excessively high tensions are required, with the result that the belt slips and its life is shortened through heating. However, a different picture is presented when automatic idlers or pivoted motor bases are used. The former serve to increase the wrap of the belt on the smaller pulley, and may be installed, according to claims, to automatically increase or decrease total belt tension in accordance with the fluctuations in the amount of power transmitted. The pivoting motor base, a recent development for short-

Preparation Fundamentals

This article is the eighth in a series of the fundamentals of modern coal preparation. Preceding articles in the series were:

I. Suiting the Plant to the Preparation Job, by J. B. Morrow, February, 1931 (Vol. 36, p. 57).

II. Structural and Construction Problems, by Andrews Allen, March, 1931 (Vol. 36, p. 125).

III. Electrification Problems in Dry Plants, by W. D. Turnbull, May, 1931 (Vol. 36, p. 247).

IV. Electrification Problems in Wet Plants—I, by E. J. Gealy, July, 1931 (Vol. 36, p. 346).

V. Electrification Problems in Wet Plants—II, by E. J. Gealy September, 1931 (Vol. 36, p. 477).

VI. Refuse Disposal at Cleaning Plants, December, 1931 (Vol. 36, p. 630).

VII. Re-treatment of Coal Middlings, by H. F. Yancey, January, 1932 (Vol. 37, p. 11).

Subsequent articles in this series will appear in later issues.

center driving, employs the weight of the motor to keep a constant tension automatically in the belt. With this equipment, the belt wrap may be as low as 110 deg. The automatic tensioning feature thus makes possible the use of flat belts for short-center drives.

Conditions in coal preparation plants frequently are such that short-center drives must be employed. Where these conditions exist, V-belt drives, as shown in the table, are often used. The drive consists of a number of rubber-and-fabric endless belts operating in V-shaped grooves in the driving and driven pulley. With this form of drive, short center distances, usually somewhat less than the diameter of the large pulley, are preferred, though the drive will operate efficiently over longer distances.

he arc of contact, according to most manufacturers, should not be less than 120 deg. on the smaller pulley; speed ratios of the driving and driven pulleys range from 1:1 up to 7:1. Maximum ratio for flat belts without idlers or other special tensioning equipment usually is placed at about 6:1, though higher ratios are feasible.

Though flat belts and V-belts can be operated at the maximum ratios, experience has shown that the transmission of power is more satisfactory when lower ratios are used. Consequently, some other form of reducing and transmitting equipment frequently is introduced between the driving and driven shaft to keep the ratio between the diameters of the belt pulleys sufficiently low to allow the belt to operate at maximum efficiency. Belts and gear trains form the combination most used in coal preparation plants, with the belt serving as the connection between the driving shaft and the gear train. Both the belt and the gears cooperate in the speed reduction, with gears for the final step.

In a number of instances, the entire reduction is accomplished by a gear train alone. Experience has shown that, in general, gear trains are efficient, easy to construct and install, and satisfactory under severe service, though noise and lubrication at times offer difficulties. The single-reduction gear drive ordinarily is used where the reduction ratio is low; double-reduction gears (designed for a reasonably high reduction, and frequently operated directly from the motor pinion by a belt or chain) quite often are applied to belt- and chain-type conveyors and elevators. Triple-reduction gears, in general, are used for heavy, slow-moving conveyors and elevators, and give a very high speed reduction. Bevel gears, usually in combination with spur gears, are used where the motor shaft is at right angles to the driven shaft, a condition that sometimes arises when space is limited.

Chains often are employed for power transmission in coal preparation plants to perform the same duties as belts. Since they are not affected by heat, cold or moisture, they give a positive velocity ratio and, depending upon speed of operation and character of service, can be used on long or short centers. Of the several classes of chains, the malleable-iron and light and heavy steel roller types generally are used as a secondary step in power transmission, and not as a direct connection between motor and equipment. Finished steel roller chains, especially the multiple types, and silent chains may be used in connecting the motor directly to the equipment.

Malleable iron chains may be composed of detachable or pinned links. Operating speed usually is not over 400 ft. per minute, and reduction ratios, according to most authorities, should not be over 5:1. Steel roller chains are made in light and heavy types, and are designed for more severe service than malleable iron chains. Reduction ratios range up to 5:1, and the maximum operating speed usually is 700 ft. per minute. Finished steel roller chains are adaptable to high-speed service. Reduction ratios run up to 7:1, and, with a single chain, speeds up to 1,000 ft. per minute may be obtained. With multiple finished steel roller chains, experience has shown that speeds up to 2,000 ft. per minute are possible. Silent chains, sometimes termed the "flexible gear," provide speeds up to 2,500 ft. per minute and reductions up to 15:1.

For all except silent chains, manufacturers, in general, recommend that the number of teeth in the smaller, or driving, sprocket should not be less than 12; with silent chain, the number of teeth in the smaller sprocket should not be less than 17. Not over 60 teeth should be used in the large sprocket. Center distances, in most cases, should not be less than the pitch diameter of the large sprocket plus one-half the pitch diameter of the smaller sprocket. Shorter centers reduce the arc of contact on the smaller sprocket, and thus curtail the life of the chain.

Progress in recent years in the design and manufacture of speed reducers to increase efficiency has been reflected in the increased use of this equipment in coal preparation plants, especially for operating belt conveyors. Present improved types of speed reducers have behind them a satisfactory record of efficiency in transmitting power, and are compact, positive in action, safe (because of the absence of exposed moving parts), and cheaper to maintain (because of the inclosed construction and well-designed lubrication systems).

Table I—Power Transmission Practice in Coal Preparation Plants

Service	Equipment	Operating Speed		Motor			Power Transmission Equipment	Speed Reduction	Speed-Changing Facilities
		R.p.m.	F.p.m.	Type	Hp.	R.p.m.			
Feeding	Reciprocating plate feeder	20–70	.....	Standard squirrel-cage	5–10	900 or 1,200	V-belts V-belts and spur gears	2.5:1 to 20:1	Variable-speed drives Varying length of stroke
Sizing	Shaker screens	70–110	.....	Standard squirrel-cage High-torque squirrel-cage Wound-rotor	10–40	900 or 1,200	V-belts Flat leather belts	2.5:1 to 7:1	Usually constant Variable-speed drives Changing pulleys
	Vibrating screens	.....	.....	Standard squirrel-cage	.....	1,200	V-belts Flat leather belts	.....	.....
Conveying*	(1) Chain-and-flight conveyors (2) Steel apron conveyors (3) Belt conveyors	....	(1) 40– 70 (2) 50– 75 (3) 250–400	Wound-rotor Standard squirrel-cage High-torque squirrel-cage	5–50	900 or 1,200	V-belts and spur gears Speed reducers	3.5:1 to 7:1†	Usually constant Wound-rotor motor
Elevating	(1) Chain-type continuous bucket elevator (2) Centrifugal discharge elevator (3) Perfect discharge elevator	....	(1) 80–150 (2) 150–400 (3) 75–150	High-torque squirrel-cage Standard squirrel-cage Wound-rotor	5–25	900 or 1,200	V-belts and spur gears Speed reducers	3.5:1 to 7:1†	Usually constant Wound-rotor motor
Crushing	Crushers	.....	.....	Standard squirrel-cage High-torque squirrel-cage	7½–75	900	B-belts and spur gears Flat leather belts and spur gears	3:1 to 4:1	.....
Air supply	Fans, large	.....	.....	Standard squirrel-cage Synchronous	50–150	900 or 1,200	V-belts Flat leather belts	1:1 to 1.5:1	.....
	Fans, small	.....	.....	Standard squirrel-cage	15–50				

*Including loading booms and conveying picking equipment.
†For certain conveyors or elevators operated at unusually low speeds, the reduction may be several times the maximum given.

Speed reducers, according to present practice, find their greatest field of application where reductions greater than those possible with belts or chains are necessary or where a multiplicity of gears would be cumbersome and expensive to maintain. In addition, reducers, because of their construction and operating characteristics, are used in a number of instances where belts and chains would serve; especially, in the case of belts, where the reduction ratio approaches the maximum. Worm gears provide a right-angle drive in the single-reduction types, with ratios up to 80:1 or 100:1. Double-reduction types have parallel shafts, offset from one another. These units provide reductions up to 10,000:1. However, the efficiency of the worm-gear unit drops rapidly at high reductions, and for this reason designers frequently employ spur-gear units for such applications. With the single-planetary spur-gear reducer, speed ratios of from 3:1 to 8:1 can be obtained. By doubling or tripling the reductions, ratios up to 500:1 are possible. Two types of non-planetary spur-gear reduction units ordinarily are marketed; one type, by doubling or tripling the reductions, giving ratios up to 300:1, and the other providing reductions between those of the planetary gear and the first type of non-planetary gear, or, without doubling or tripling, from 3:1 to 7:1. Spur-gear units have shafts in line; right-angle drive is possible by the use of bevel gears.

A third widely used type of gear-reduction units employs herringbone gears, with reductions as follows: single, 1.5:1 to 10:1; double, 10:1 to 80:1; triple, 80:1 to 350:1. Shafts in herringbone units are parallel but offset from one another. Silent chains form the basis of another class of reducers, offering a wide range of single- and double-reduction units. Other units employ combinations of chain drives with spur-gear reductions and other types of equipment

Reduction units may be installed with direct connections to the motor and driven equipment or, as often is the case, with belts, chains, or spur gears between the motor and the reduction unit, or between the reduction unit and the equipment. Use of intermediate power-transmission equipment has been found, in a number of cases, to give increased flexibility where shock loads are likely to be encountered. In certain instances, though seldom used in preparation plants, worm and planetary units or other types of reducers may be operated in tandem to give a greater reduction than could be obtained with a single unit.

Where the rate of operation of feeders, shaker screens and similar equipment must be changed to meet variations in the quantity of material handled, some form of variable-speed transmission occasionally is used. This transmission unit consists of two wheels, each made up of two halves with opposing conical faces. The wheels are connected by a belt of metal or rubber-and-fiber. One wheel is connected to the input shaft and the other to the output shaft. To vary the speed, the opposing halves of one wheel are separated, while the distance between the halves of the other wheel simultaneously is decreased, thus varying the effective pitch diameter of the output wheel. Speed variations are made by a handwheel on the outside of the case inclosing the transmission, and the range of output speeds is infinite between the limits of reduction. Reductions up to 16:1 are possible, depending upon the type of transmission.

Variable-speed motors are employed in some instances where changes in the operating rate of coal preparation equipment, particularly conveyors, are desired. In general, however, constant-speed squirrel-cage motors are most frequently used, as shown in the table. These usually are started directly across the line. Where friction or load requires a high starting effort, high-torque squirrel-cage induction motors are employed. These give starting torques from 2 to 2½ times normal-load torque. For general use, where the starting torque is not more than 1 to 1½ times the full-load torque, normal starting torque, high-reactance squirrel-cage motors are used. These motors are designated as "standard squirrel-cage motors" in the table.

Wound-rotor motors are so designed that the speed can be varied, after which the motor will operate at the desired speed without further attention, provided there is no change in load. Variations in speed are obtained by the use of slip-rings, between which are connected variable resistances. By varying the resistance, the speed may be changed in accordance with the rate of feed. Multi-speed squirrel-cage motors also are used in certain instances to give a number of speed changes. These changes are accomplished by regrouping the coils on the stator to alter the number of poles.

Usual motor speeds, as revealed by the *Coal Age* survey, are 900 or 1,200 r.p.m. Relatively low-speed motors were more desirable in the older days when flat belts were used exclusively, as with the higher-speed motors the small motor pulley, large driven pulley, and long belt centers necessary to reduce slippage to a practical value made the problem of connection a difficult one. With the advent of the V-belt and the various types of speed reducers, opinion seems to support the view that even higher motor speeds than those used at present will be employed in the future. This trend offers the further advantage that higher speed motors are less costly, have a higher efficiency and are cheaper to operate. Close adjustment of cleaning-plant operation, it has been found, requires better regulation of speed, which indicates that more variable-speed transmissions will be used in the future. The wound-rotor motor, frequently used for this purpose, is more expensive than the squirrel-cage motor and when operating with resistance in the circuit will not hold to a constant speed lower than normal if the load changes.

Because of the fact that it is practically impossible to prevent misalignment of two connected shafts when installing equipment or after it is in service, flexible couplings frequently are used in coal preparation plants. With such couplings, a certain amount of misalignment can exist between connected shafts without injury to the equipment or interruption of service.

Nova Scotia Institute Discusses Modernization

(*Continued from page 272*)

hand-pick operation on the strike, steel support gives excellent results. Midwalls are not used and posts are set 4 ft. apart and in rows 4 ft. distant with corrugated straps 5x5½x¼ in.

In Princess colliery, with 250-ft. machine-cut faces on dip and rise, good results were also attained with 5-in. composite pipe steel props having ¼-in. straps. Undercuts are 4½ ft. deep and the posts are set in rows 4½ ft. apart with 4-ft. centers. When the undercut was increased to 6 ft. and post rows were set 6 ft. apart, with posts 3 ft. apart along the row, the posts being surmounted by 7-ft. straps, trouble began; props entered the floor at times as much as 20 in., rendering extraction difficult. The straps also were bent and displaced. So three midwalls are now being constructed, and high hopes are entertained.

Within the last two years at Dominion No. 12 colliery over 3,000 steel arches have been erected at 3-ft. centers, a distance of nearly two miles. Where the arches are in advance of the longwall faces, hardwood stilts are used to provide for 1½ to 2 ft. of subsidence additional to that which the arch would otherwise afford. These stilts consist of two pieces of hardwood, 2 to 3 ft. long, fitted snugly between the flanges and in contact with the web of the girder. They are held in position by two screw clamps set up just tight enough to permit the girder to slide when the roof weight is almost, but not quite, as great as the girder can resist. In some places the arches are set on H-beams laid on pack walls, these arches being of semi-circular form.

The Canadian Institute of Mining and Metallurgy, which was represented at the Baddeck meeting by E. J. Carlyle, secretary-treasurer, cooperated with the Nova Scotia society in preprinting a number of the papers presented in the June issue of "The Canadian Mining and Metallurgical Bulletin."

NOTES

. . . from Across the Sea

A MEANS of adapting magnetic induction to face lighting that entirely eliminates sparking switches has been developed in Great Britain by Prof. W. Cramp, who recently described his system to the South Staffordshire and Warwickshire Institute of Mining Engineers at Birmingham, England.

In Great Britain usually only alternating current is available at mines which use electricity, and as the machines are well inby, the current has to be at relatively high pressure—about 500 volts—and the lighting circuit must be at the same high voltage as the machines, unless a transformer is provided. As the higher voltage lamps are fragile, a lamp should be used which is suited to relatively low voltage—some say as low as 12 volts.

In order to be able to put a lamp in the circuit when it needs replacement, and to do it without turning off the current on other lamps and without the use of sparking switches, this lamp (see illustration), which works by magnetic induction, has been devised. The primary is sealed in the lower part of the steel inclosure, and when the lamp with its secondary is inserted, it lights up without the turning of a switch.

By turning the wing nut, the lamp with its well glass and base can be removed, taking with it its secondary coil and yoke. This action immediately extinguishes the lamp without opening any switch. One or more bulbs could be used, though in the apparatus as constructed only one 100-watt 25-volt lamp was provided.

In Prof. Cramp's system all the lamp primaries are in series, yet if a lamp goes out, the other lamps continue to burn unless the primary is short-circuited. With twenty-one 100-watt lamps in a circuit—this being thought sufficient for a 100-ft. face—with no lamp in place, the primary current is 11.25 amp. on normal full voltage, and with all lamps burning only 2.2 per cent less. With one-third of the lamps removed, the current increases 1.3 per cent. With one-third of the lamps dead short-circuited, the current does not exceed 13.7 amp. With one-third of the lamps burned out, the current falls only 7.5 per cent. From these figures, it is evident that the current under working conditions is reasonably steady.

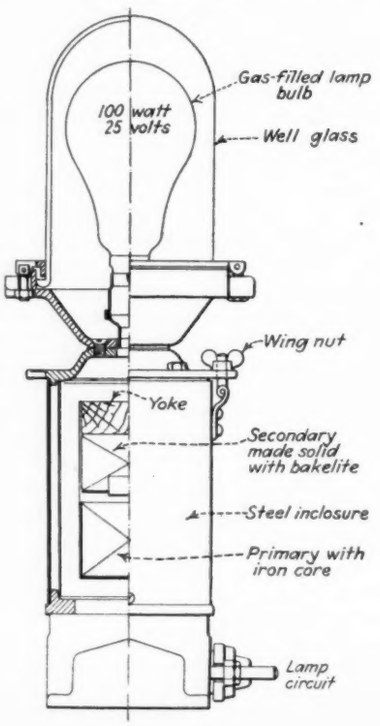
If a lower voltage in the lamp main is desired, a transformer can be placed at the connection with the mine power system. J. C. Mitcheson is experimenting with 12-volt lamps at Birch Coppice, in order to get a filament that will be more enduring than one using 125 volts.

Would the arrangement, he asked, be operable with only two or three lamps in series? He questioned also whether it would be safe to put 550 volts through the lamp cable. What appealed to him was the freedom from plugs, but he feared that the cable would be so heavy and difficult to handle that plugs would have to be inserted in order to divide it in sections.

He had found that where men were furnished with spare lamps they seemed more careless in their use and breakages were frequent. This reduced the advantage to be obtained from the ability to remove and replace a lamp. This power of removal was of great value when shotfiring, for with the suggested system a lamp, or lamps, could readily be removed.

With the lamps set at given distances along a given line, it became impossible to provide for the placing of the light when it was not convenient to a prop, and it was not possible to advance a light toward the face when the coal had been loaded out along the line of face until such time as all the lights were moved forward. The lamps also were so large that they could not be hung close to the roof, where the light would be given maximum spreading effect.

Lamp, Operated by Magnetic Induction, Without Switches to Spark and Ignite Gas



Such an installation would have to be supplemented by portable lights in case of failure of any or all the lights, and, moreover, the men needed such lights to use in walking to the face.

Semi-portable lamps supplemented by hand or cap lamps appealed to Prof. W. H. McMillan as preferable to fixed lights from mains, but L. Holland declared that accumulator lamps of adequate power for stationary lighting were so extremely heavy as to be undesirable.

A short, thick filament would last longer than a light one, but, unfortunately, when broken, as it might be by a fall, it would cool very slowly, said G. Allsop, Safety in Mines Research Board, Sheffield. Such a filament would take 1 to 2 seconds to cool from its working temperature to 1,200 deg. C., at which temperature methane would be almost immediately ignited, whereas high-voltage filaments would cool rapidly and a cutout could be applied to such filaments, which would extinguish them if the bulb were broken before the methane could be ignited.

Moreover, Prof. Cramp had designed his equipment for 440 volts on the primary, whereas the Mines Department would not allow more than 125 volts to be used for portable equipment at the coal face. Unless the primary windings, therefore, were redesigned to take less than the 20 volts, as required by Prof. Cramp's equipment, no more than six transformers could be placed in series on one phase. Protection against the cutting of the cable could be afforded by a tripping device that operated when the current fell below a predetermined fraction of the current under full load. This would be satisfactory only if the device operated in less time than was needed to sever the cable. Otherwise, a highly inductive circuit would be broken and the flash would ignite gas.

Constant-potential, constant-current series systems of lighting were not novel, said C. H. Nunn. The General Electric Co., Ltd., had installed them on aerodromes for boundary lighting, and they had been used in America for street lighting. But the method of isolating the secondary winding of the transformer and lamps was new. In contradistinction to Prof. Cramp, he thought that the secondary of the transformers should be grounded, as he had found the potential to earth of the ungrounded secondary rose much above the normal voltage of the winding.

Could it be so arranged that the lamp might be removed from the secondary when—and only when—the secondary and lamp had been separated from the primary? asked Prof. Henry Briggs. This would make it unnecessary to provide at the face as many spare secondaries as spare lamps.

On the life of the tungsten lamp filament, face lighting would stand or fall, said J. A. Horsley, electrical inspector of mines. The transformer made it possible to adopt any lamp voltage which might be found desirable. However, with continuous current a rotary trans-

former could be used that would make it possible to obtain any voltage desired, though the cost was an objection.

No permanent satisfaction, he believed, would be obtained with a lamp voltage greater than 12. He did not agree that the series system was preferable for face lighting to the system in parallel, and he feared that the provisions for keeping the lamp voltage constant would be entirely masked by fluctuations in the main power system.

Prof. Cramp admitted that a breakage of his cable would be more serious than an ordinary short-circuit, because much magnetic energy would have to be dissipated when the cable broke.

R. Dawson Hall

On the ENGINEER'S BOOK SHELF

Flotation, by A. M. Gaudin, research professor of ore dressing, Montana School of Mines. McGraw-Hill Book Co., New York City. 552 pp., 5¾x9 in.; cloth. Price, $6.

In the few brief years since the outbreak of the War, flotation has made great strides, the nature of which are skillfully recorded by the author of "Flotation." The physics of the atom has made such progress that the mysteries of surface tension and with them the mysteries of flotation seem on a fair way toward solution. The author gives space to the physics of the subject and passes on to the mechanical aspects of froth production, liberation of concentrate and importance of particle size, followed by flotation practice with various metallic ores.

Latterly come studies in the floating of non-metallic mineral, treating first the non-polar, highly floatable group—sulphur, graphite, bituminous coal and anthracite. Coal receives eight pages of comment, based principally on the studies of O. C. Ralston, U. S. Bureau of Mines, published in 1922, and the British experiments reported by C. H. S. Tupholme in the following year.

* * *

Regulating an Industry, by A. H. Stockder, Columbia University Press, New York City. Pp. 154 and index; 6x9 in. Price, $2.50.

This study of the operations of the Rhenish-Westphalian Coal Syndicate from its organization in 1893 to the end of 1929, based upon a review of German literature on the subject, should have more than passing interest for coal men in the United States, because they, too, are struggling with some of the same problems which confronted the German operators who brought the first syndicate into being. The author, an associate professor of business administration at Columbia University, who made an earlier study of trade associations in the German coal industry in 1924, examines the operations of the Westphalian syndicate from the standpoints of production control, marketing policies and the regulation of distribution, price regulation and labor policies.

Readers looking for full-blown industral perfection at birth will be disappointed in Prof. Stockder's recital. Concessions and compromise have been made repeatedly to preserve the existence of the syndicate against threatened demises. Integration in German industry has added to its problems and the adjustment of controlled tonnage as between captive, free commercial and integrated mines has raised many knotty questions. The World War gave the institution a new lease on life at a time when its end had been generally forecast; the order of the new German republic making the Westphalian syndicate a pattern for the organization of other coal-producing districts increased its prestige and solidity.

The author's frank recognition of the limitations in the stabilizing scope of this pioneer organization is, possibly, the most valuable contribution he makes to the discussion of an institution that has been frequently treated piecemeal and sometimes panegyrized. Prof. Stockder sees both the perfection and the imperfections and summarizes both admirably in his concluding chapter. Careful reading of this volume may make some of us less impatient with the failure of efforts here to reach that impeccant state that exists only in the unattainable ideal. S. A. H.

* * *

General Engineering Handbook, by C. E. Rourke, assistant professor of structural engineering, Cornell University, editor-in-chief, assisted by 29 associate editors. McGraw-Hill Book Co., New York City. 921 pp., 5x7¾ in.; artificial leather. Price, $4.

As mining engineering covers almost all forms of engineering—civil, mechanical and electrical—this general engineering handbook should be of interest to all mining engineers. It is newly compiled and the work of 30 persons, all versed in their several lines of work and free to pick and choose what is most likely to be of service to the engineer. The volume, therefore, is representative of the best modern practice. It is also a handbook in a real sense. Most handbooks are really overgrown pocketbooks, too bulky to put in the pocket and difficult to keep open till their backs are hopelessly broken and the book ready to fall in pieces. There are virtues in a page of a size adequate for tabular matter and bound in a book of normal dimensions.

Though the handbook contains a large number of pages, they are thin and printed in a small type; thus a mass of information is afforded in small compass and light weight. Nowhere in the book is there any reference to mining, but hardly a page lacks matter of interest to the man engaged in that work. Today the mining engineer is assailed with all kinds of questions. What is the advantage of such and such a metal for this or that part of a piece of equipment?—how should a foundation be obtained under a given unfavorable condition?—what provision should be adopted for a water supply and how shall the water be treated for potability and industrial use? Answers to such, and many other diverse questions readily arranged for reference, are provided in this volume. R. Dawson Hall.

* * *

The Story of Anthracite. Hudson Coal Co. 425 pp., 5½x8¼ in.; cloth.

Everyone with an interest in anthracite will welcome this authoritative book, which should be widely read and available in all public libraries for anyone who wants reliable information on the geology, geography, discovery and transportation of anthracite; its mining, preparation, management, labor, labor relations, wages, markets and public relations.

Those pages which refer to geology, however, might arouse some questioning comment. The statement on p. 5, for example, that "all coal has a common origin," and "all coal belongs to one class," on p. 7, are rather broad declarations needing qualification, which they fail to receive, for the cannels and boghead cannels are generally believed to be outside the general run of coals. Nor, can we feel sure that all lignite "occurs in formations lying above the carboniferous measures." Some lignite in Germany is said to be older than some carboniferous measure coal.

One other matter in which this, as every other anthracite book, is defective, may be mentioned. The first white man to discover anthracite probably was Count Nicholaus Zinzendorf, who, having opened his estate in Saxony as a refuge to the dissenting bodies of Europe, came to America and landed in New York, Dec. 2, 1741. He visited the Wyoming Valley in 1742 and lived for a while among the Shawnees. These Indians had a coal mine on Ross Hill, now a part of the borough of Edwardsville, Pa., references to which appear in his diary. Ultimately, Jan. 20, 1743, he left America via New York for Herrnhut, a village erected by the Unity of Brethren, or Moravian, Church, which had been founded under his guidance.

R. Dawson Hall.

OPERATING IDEAS

From Production, Electrical and Mechanical Men

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How a Synchronous Motor Was Fitted To a Mine Fan

During the past year, the Westmoreland colliery of the Lehigh Valley Coal Co., at Wyoming, Pa., was electrified. One of the units affected by the change, writes E. R. Wagner, electrical engineer of the company, was the ventilating fan. The steam-driven unit was an 18-ft. diameter, straight-paddle, double-inlet exhaust fan, which drew its air from the Pittston and Marcy beds. A vertical shaft of 8x10-ft. section and 90 ft. long connects the Marcy with the Pittston bed. The air traveled 100 ft. in the workings of the latter bed to a second shaft, also of 8x10-ft. section and 50 ft. deep, to the fan intake.

As the airway in the Pittston bed was contracted and crooked, it was deemed advisable to drive a new shaft of 14x14-ft. section from the surface directly over the Marcy-Pittston shaft and to locate a new electrically driven fan near the top of this new shaft. The new fan is a 10x5-ft., double-inlet, nonreversible, exhaust ventilator of the stepped multi-bladed type, connected to the airshaft by a drift with an area of 127 sq.ft., having brick side walls and reinforced-concrete slab roof. The fan shaft is supported on three bearings of the ring oiling type, and extends through the brick wall of the side drift into a brick house in which are located the driving motor, starter and reduction gear.

As first installed, the motor was a 125-hp., 2,200-volt, 3-phase, 600-r.p.m., 60-cycle, line-start, synchronous unit, having 80 per cent leading power factor with direct-connected exciter, and provided with two ball bearings. Motor, reduction gear and fan were originally connected by flexbile couplings, but the coupling between the motor and gear was changed, as described later. The fan has a normal capacity of 204,000 cu.ft. per minute at 2.5-in. water gage, when running at a speed of 156 r.p.m., and the WR^2 of the revolving parts is 77,600 lb. ft.^{2}

As it was proposed to run this fan without stationing an attendant in the motor house, the electrical control equipment was made as simple and foolproof as possible. The motor being of full-voltage starting type, a hand-operated oil switch in the primary leads could be used satisfactorily. This switch remains closed except when it is opened either manually to stop the fan, or electrically by the operation of overload relays. The latter, of the induction type, are prevented from operating during the starting period by a double-pole relay, which short-circuits the secondary leads of each current transformer.

On starting, this relay is closed by a back contact on the mechanical timing field relay, with power obtained from a 20:1 potential transformer. This timing relay is adjusted to complete its timing when the motor has reached about 95 per cent synchronous speed, and, on operation, it closes the field contactor applying excitation to the motor field and drops out the short-circuiting relay on the current transformers, thus putting the overload relays in circuit. The inherent time delay of these latter relays is sufficient to prevent their being operated by the slight disturbance which the closing of the field contactor occasions. All the 2,200-volt wiring and equipment are mounted in the rear and inclosed by a wire screen so that only the colliery electrician has access to them.

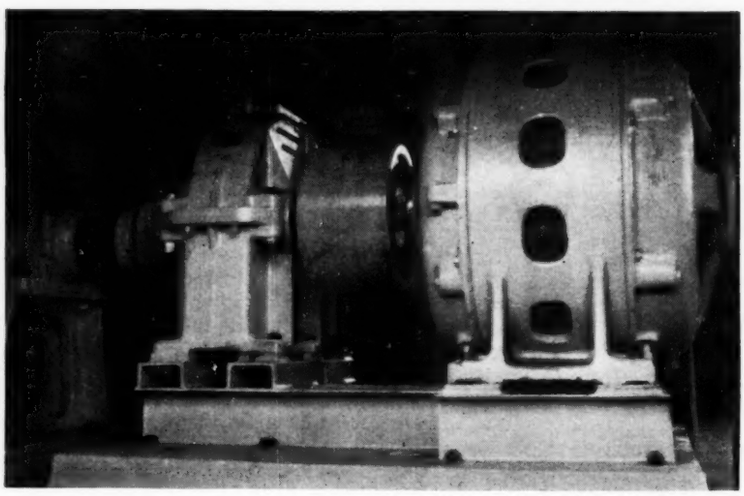
Characteristics of the fan motor are given in the following tabulation:

	Original Motor	Motor with Rewound Stator
Rating, hp	125	180
Power factor, per cent	80*	100
Kva. inrush, per cent	425	425
Starting torque, hp	125	170
Pull-in, torque, hp	138	185
Pull-out torque, hp	250	380
Motor input with normal load on fan, kw	100	100

*Leading.

On starting the fan, it was found that the original motor would accelerate the

Fig. 1—Snub Starter Between Motor and Speed Reducer



fan to a constant speed in about 22 seconds, so the field timing relay was adjusted to close the field contactor after this time interval. The motor did not, however, have enough pull-in torque to pull itself and the fan wheel into step, but kept slipping back until the overload relays tripped the oil switch. It was only after much coaxing that the motor and fan could be brought up to synchronous speed.

This method of starting obviously was out of the question for automatic control, so it was proposed to rewind the stator of the motor, increasing the pull-in torque from 115 kw. to 152 kw. input. This greatly improved conditions, but still there were times when the motor would fail to pull into synchronism, so that the operation could not be considered 100 per cent perfect, which is a necessary requirement for most ventilating fans.

Repeated trials showed that the motor had ample torque to start the fan, but that by the time the fan and motor were up to the proper speed point for bringing in the field contactor, the fan wheel had picked up so much mechanical load that the pull-in torque was not always sufficient to guarantee that the motor would pull into synchronism every time. It was seen that if it were possible to get the motor into synchronism before this speed point on the fan wheel was reached, the motor pull-out torque, which was double the pull-in torque, would be available for this work.

This condition was made possible by the removal of the flexible coupling between the motor and speed reducer and by substituting for it a Bethlehem snub starter. This device is essentially a friction clutch, which can be designed to develop a constant torque of any value that may be desired. It consists of a steel spider keyed to the motor shaft and provided with two, three or four arms, set respectively 180, 120 or 90 deg. apart, as required for the torque to be transmitted.

On each of the arms is hung an asbestos-faced band similar to the expanding brake band on an automobile. This band is so hung that the arm of the spider pulls one end around with it, while the other end is free to fly outward, due to centrifugal force. The spider and bands are inclosed in a cast-iron drum, which is keyed to the driven shaft. When the motor starts to revolve, the bands fly outward against the inner circumference of the drum and commence to drag the latter around with them. The torque developed depends upon the weight of the bands and their speed.

With this device it can readily be seen that the motor can be brought up to synchronous speed and the field applied before the speed of the fan wheel reaches a point where any mechanical load is picked up. Fig. 1 shows the relative sizes of motor, snub starter, and speed reducer. Mr. Wagner was fortunate in having an opportunity to obtain a high-speed wattmeter record of the starting conditions, both before and after the installation of the snub starter. These are compared on the accompanying chart, Fig. 2. The curve with a high, broad peak of 312 kw. was obtained when the flexible coupling was used. This shows a gradual acceleration of the fan wheel and, at the end of 22 seconds, the motor being at nearly synchronous speed, the field contactor closes, causing another violent disturbance not quite so severe as the one at starting, and, after a few swings, the motor pulls into step. Four starts were made at the time the meter was connected, and during one of them the motor failed to start successfully.

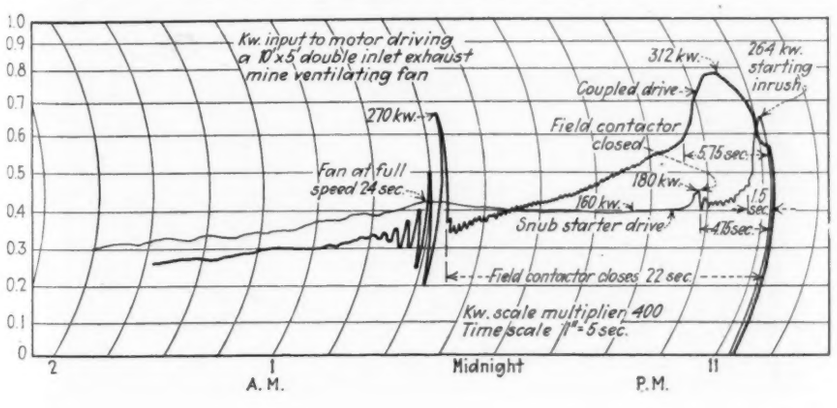
After the snub starter was installed, a second curve was taken, with no change in fan conditions, showing the input to the motor with the new connection. The starting inrush is reduced to 264 kw., and lasts about 25 per cent as long as the former peak. The apparent decrease in the starting inrush current is due, no doubt, to the fact that the motor accelerates so rapidly that the current starts to decrease before the pen of the meter, because of its inertia and friction, has had a chance to record the maximum value. It should, of course, be the same as in the former case but of much shorter duration.

In 5 seconds the motor is up to speed and the throwing on of the field causes but a slight disturbance. The snub starter then continues to accelerate the fan wheel and brings it to full speed in about the same length of time that was required with the flexible coupling. That constant torque is developed by this device is clearly shown by the curve, the slight rise about at the full-speed point being occasioned by the change from rubbing to static friction between the bands and the drum. After a short period of operation, the input, due to the mechanical load, settles down to the same value in each case. Since the installation of the snub starter, the motor has never failed to start the fan properly, and it is felt that this installation is now 99.99 per cent perfect.

What's the Answer?

Running a coal mine means meeting and solving the daily quota of problems growing out of equipment operation and maintenance, preservation of life and limb, and production of the required tonnage at the lowest possible cost. Little difficulties may mean big losses unless the antidote is immediately at hand. The operating ideas in these pages represent practical solutions of the many every-day operating problems of value to all mining men. Your idea has its place among them. A sketch or a photograph may make it easier to understand. Acceptable ideas are paid for at the rate of $5 or more each.

Fig. 2—Starting Conditions Before and After Installation of Snub Starter

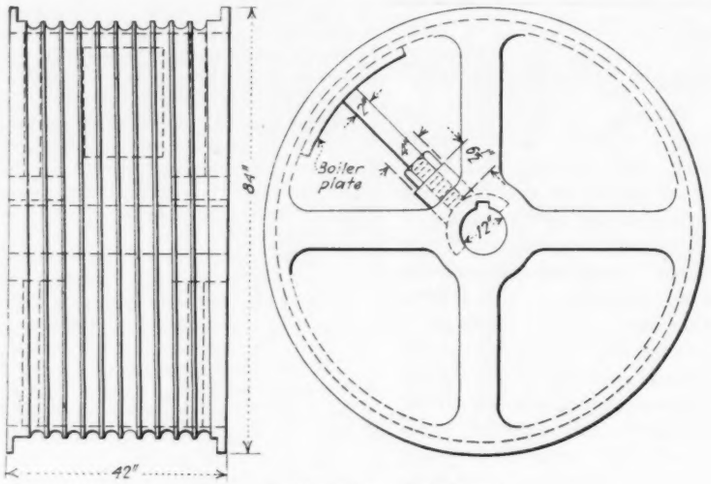


Crack in Hoist Drum Reinforced With Boiler Plate

During an inspection of machinery at a West Virginia mine in 1920, a crack was found in the cast-iron drum of a hoisting engine. To replace this drum would have involved great expense, and as the unit operated at low speed, it was felt that a repair of the break might be safely and economically attempted.

Details of the job are furnished by E. C. Tillson, of Cassity, W. Va. At each end of the drum was a hub 12 in. long, and between these two hubs 18 in. of the shaft was exposed, as shown by the sketch. It was directly over this exposed section of the shaft that the break occurred.

The first step involved the drilling of a ½-in. hole at the extremities of the cracks to prevent their extension. Then a brass casting was made as a half-journal to fit over the shaft, as indicated. This bearing had a length of 10 in. and was machined to a neat fit. The boiler plate under the crack, measuring 16x18 in. and ½ in. thick, was bent to conform to the curvature of the inside surface of the drum. As this



How Cracks Were Reinforced

inside surface was quite rough, it was found necessary to close the irregularities, which was accomplished by first heating the cracked zone of the drum, also the boiler plate, and pouring lead between them.

A boss was formed of the casting by drilling a hole and tapping it to a 2-in. U. S. Standard thread. A shaft was turned and threaded at the boss end to extend from this boss to the boiler-plate support. All being ready, the bearing was taken up lightly against the shaft and the locknut tightened. Though the weight of the parts used in making the repair threw the drum somewhat out of balance, this fault could not be detected in the running because the r.p.m. was low. The repair lasted the eleven years the hoist continued in service.

Rail Bond Economics Found By Formulas

When choosing a rail bond for a given track return circuit, major consideration should be given to the size of bond that gives the most economical operating conditions, after due allowance for mechanical requirements and current capacity. In order to arrive at the most economical bonding for a given joint, a formula has been derived by equating the yearly power losses in the bond to the yearly interest and depreciation charges on the total cost of bond installed.

Assume that W is the weight of rail in pounds per yard; C, total installed cost of bond in dollars; I, root-mean-square of current during operating period; p, cost of power in dollars per kilowatt-hour; R, reduction in joint resistance resulting from installation of larger or additional bond expressed in feet of rail; r, rate of interest on invested capital (decimally expressed); and n, life of bond in service in years.

With a 12:1 steel to copper resistance ratio, the resistance of a steel rail is close to $\frac{0.001}{W}$ ohms per foot.

Actual savings in power when a larger or additional bond is applied to a joint is $\frac{0.001\ RI^2}{W}$ watts. Assuming operations of 5,000 hours per year, the annual power savings would be

$$\frac{0.001\ RI^2}{W} \times \frac{p}{1000} \times 5000, \text{ or}$$

$$\frac{0.005pRI^2}{W} \text{ dollars.} \quad (1)$$

Dollar savings per year (annuity) required to balance the total cost of the bond installed over the period of its life are

$$C\left[\frac{(1+r)-1}{(1+r)^n-1}\right] \quad (2)$$

Whenever the annual power loss given by equation (1) is in excess of the annuity in equation (2), then it becomes economical to install an additional bond or else replace the old one with a larger one. The ideal size of bond is obtained by equating (1) and (2) thus:

$$\frac{0.005pRI^2}{W} = C\left[\frac{(1+r)-1}{(1+r)^n-1}\right] \quad (3)$$

Solving for I:

$$I^2 = \frac{WCr}{0.005pR\ [(1+r)^n-1]}$$

and

$$I = \frac{WCr}{0.005pR\ [(1+r)^n-1]} \quad (4)$$

To apply the above equation to an actual problem, suppose a mine with 60-lb. rail desires to know whether to use 2/0, 32-in. bonds or 4/0, 32-in. bonds, or perhaps double bonding with 4/0 bonds. The present installed cost of a 2/0, 32-in. bond is approximately $0.80 and a 4/0 bond installed is $1.21. Assume the average power cost at $0.015 per kilowatt-hour, rate of interest on invested capital at 6 per cent, and life of bond as five years. From bond resistance tables, a 2/0, 32-bond installed is known to be equivalent to about 12.8 ft. of 60-lb. rail and a 4/0, 32-in. bond installed is equivalent to about 8.1 ft. of rail. The equation for 2/0 bonds can be set up thus:

$$I = \sqrt{\frac{60\times0.80\times0.06}{0.005\times0.015\times12.8\ [(1+0.06)^5-1]}} = 91 \text{ amp.}$$

Thus 91 amp. is the most economical current to use.

For the 4/0 bond the most economical current is

$$I = \sqrt{\frac{60\times1.21\times0.06}{0.005\times0.015\times\ 8.1\ [\ (1+0.06)^5-1]}} = 139 \text{ amp.}$$

To find the current value at which it is more economical to use a 4/0 bond than the 2/0 bond, the following equation is set up:

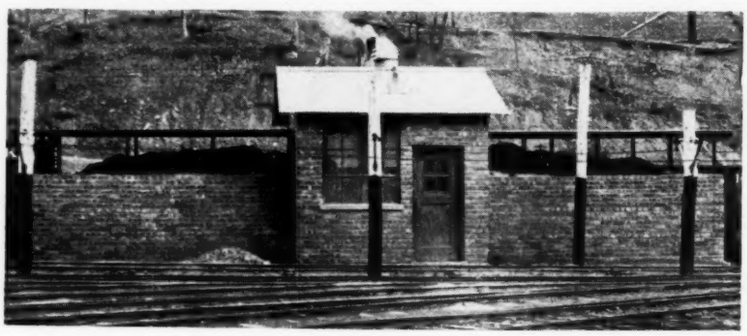
$$I = \sqrt{\frac{60\times0.41\times0.06}{0.005\times0.015\times\ 4.7\ [(1+0.06)^5-1]}} = 106 \text{ amp.}$$

From the foregoing it is seen that the size and length of a rail bond is determined economically after the average current through a given rail is known. By the use of the formulas given, anyone should be able to determine the proper bonds for his particular conditions.

Improved Air Conveying Sand System Built at Nellis

Some time ago the local management of the Nellis (W. Va.) mine of the American Rolling Mill Co. recognized the necessity for better facilities for drying and handling locomotive sand. When William Jayne, mine foreman, saw in *Coal Age* (Vol. 35, p. 53) a pneumatic conveying system, he lost no time in planning and building a new sanding layout at the

Fig. 1—Raw Sand Is Stored on Each Side of the Dryer House



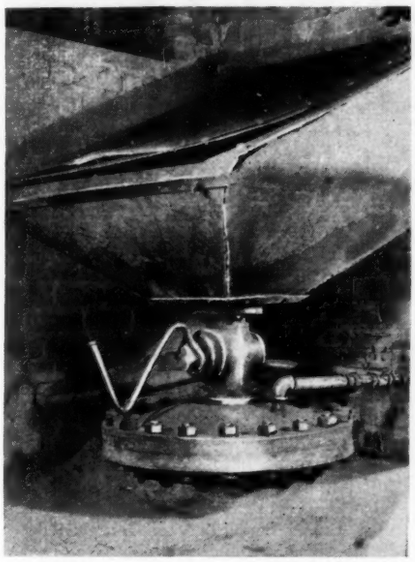


Fig. 2—Screen, Hopper, Cock and Pressure Tank Top

Nellis mine. He utilized the same principle of air-pressure conveying from sand drying house to the elevated sanding tank, but incorporated several ideas which facilitate handling.

The sand dryer building, Fig. 1, is located in the center of the raw sand storage bin, or rather between the two sections of the bin. This reduces to a minimum the distance that the sand must be moved when it is shoveled into chutes leading into the dryer stove hopper. Armco galvanized roofing supported on steel protects the raw sand from direct rain.

The pressure cylinder or tank into which the dried and sifted sand is placed preparatory to being blown through a pipe line is sunk into the floor in a corner of the dryer room. The top flange (Fig. 2) is fitted with a stopcock connecting with a dry-sand hopper. The sloping screen removes foreign material from the dried sand and forms the cover of the charging hopper. After a hopperful of sand is allowed to run down into the cylinder the stopcock is closed and the air pressure turned into the cylinder to blow the sand to an elevated tank.

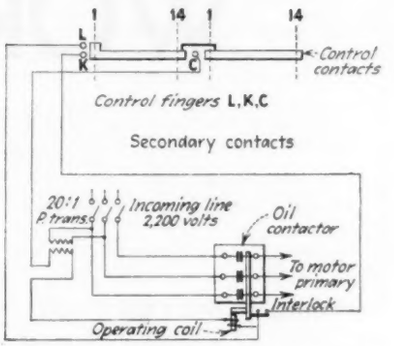
Fig. 3 shows the tank arranged midway between two tracks and close to the mine portal. The pneumatic conveying line from the sand house to the sand tank is carried underground.

Non-Reverse Manual Controller Made Semi-Automatic

Needing a control for a 350-hp. a.c. 2,200-volt motor for use on a one-way hoist, the electrical force at a Southern mine found a large slip-ring controller with fourteen points an ample number for starting and running. The controller, however, had no provision for primary contact or control, and to place a 2,200-volt circuit on the drum would not have been safe. Finally, there was found a primary contactor with oil-immersed contacts, which was operated by a 220-volt contactor magnet.

This contactor, states Grady H. Emerson, Birmingham, Ala., was arranged for interlocking contacts, so that if the voltage failed, the controller would have to be placed at starting position before voltage could be applied to the motor. But there still remained the problem of controlling the contactor from the slip-ring controller. After careful measuring, it was decided to place these contacts at the top of the drum just above the main contacts.

The main fingerboard was extended 2½ in. on each side, the fingers *LK* (see diagram) were placed on the left, and *C* on the right. These segments were fastened to a ¾-in. disk of fiber with machine screws, and connections were made as shown. On the first point of the controller full resistance is in the rotor circuit. On the second point the finger *L* is opened and the primary switch circuit is then through the interlock on the contactor. If this arrangement were not provided it is possible, should the voltage fail while the motor is in operation, that the voltage might be applied when the controller is in open position.



Changing Non-Reversing Secondary Controller to Control Primary Contactor

Joints in Blower Tubing Made With Stove Pipe

At the New Orient mine of the Chicago, Wilmington & Franklin Coal Co., West Frankfort, Ill., where pressure blowers and tubing are used to a great extent for auxiliary ventilation in entry driving, a convenient, economical and effective method is followed in repairing torn tubing and making joints. The ends are lapped over an 8- to 10-in. length of small-gage galvanized sheet-iron pipe and fastened with wrappings of cord. Thus the full diameter of the tubing is maintained.

Asphalt Emulsion Bonds Patched Concrete

To patch the concrete floor in the shop, substation, pumproom and other places in and about the mine, asphalt emulsion can be used to advantage. It is especially good where moisture and freezing would tend to cause chipping along the line between the old and new concrete. Proper use of the emulsion makes it possible to secure a watertight bond between the old and new work.

After all loose material is brushed or chipped from the edges of the old concrete, these edges are painted with the emulsion. Next a batch of patching material made up of two parts sand and one part cement is mixed dry. Instead of bringing this to workable wet consistency by adding water, a "50-50" mixture of water and emulsion is added.

If the patch is troweled thoroughly as a finishing process the new material will not be as dark colored as might be expected but will be close to the color of the old.

As the name implies, asphalt emulsion is a mixture of natural asphalt and water. In the manufacture, the water is added only to thin the asphalt to handling or spreading consistency. Upon exposure, the water gradually evaporates and leaves the asphalt in its natural state.

Fig. 3—Dry Sand on Tap Through a Hose

WORD from the FIELD

Union Pacific Old Timers Celebrate

Again waking the echoes at Rock Springs, Wyo., the Union Pacific Coal Co. Old-Timers' Association gathered on June 11 for its eighth annual celebration to the tune of brass bands and Scottish pipes. The annual business meeting and election of officers was the first event on the program. Stanley Preese, Rock Springs, was elevated to the president's chair. Released from weightier matters, the celebration got under way with a parade headed by Carl R. Gray, president, Union Pacific Lines; Scott Turner, Director, U. S. Bureau of Mines; Eugene McAuliffe, president of the company, and his granddaughter, Jean Tucker; George B. Pryde, vice-president and general manager; and James Moon, oldest employee, who saw 58 years of service before retiring. A banquet was followed by addresses by Mr. Turner and Mr. Gray, after which Mr. McAuliffe presented gold 40-year buttons to nine men.

In accordance with annual custom, the celebration was preceded by a first-aid field day on June 10. Leaders among the men's teams were: Hanna No. 2, Hanna No. 1 and Tono. A feature of the day was the presentation by Mr. Turner of the Joseph A. Holmes Safety Association citations to the "C" mine, Superior, and the No. 4 mine, Rock Springs, for outstanding safety records.

Sponsors Amend Davis-Kelly Bill; Other Measures Proposed

Senator Davis, Pennsylvania, on June 11 submitted to the Senate Subcommittee on Mines and Mining an amended measure designed to answer in part the objections of producers, consumers and railroads to the original Davis-Kelly bill (*Coal Age*, Vol. 37, pp. 211, 255). Under the amendments, licensees would pay a fee of one mill per ton on shipments to defray the administration expenses; zoning powers would be specifically denied the proposed coal commission, and clauses to the effect that applicants for licenses must agree to abide by any rules or regulations promulgated by the commission and the section on switch connections to mines were eliminated.

The amendments also provide for court review of the commission's orders. In hearing applications to organize selling pools or to modify or revoke licenses of such pools, the commission, says the amended bill, shall make its findings that the schedule of prices established does or does not provide a fair and reasonable return, including a fair and reasonable profit and wage scale.

A new bill also was introduced in the House by Representative Kelly last month. The Kelly bill, except for the definition of corporations shipping in interstate commerce, is the same as the Davis bill.

Senators Davis, Hatfield and Hayden plan to file separate reports on the bill with the Senate Committee on Mines and Mining. The nature of Senator Hatfield's report has not been made public. Senator Davis will support his amended bill, while Senator Hayden has offered a substitute measure, based on the taxing power of Congress; this measure would force producers into a Coal Protection and Conservation Association similar to the British cartel. A tax of 10 per cent would be levied by Congress on the value of the coal at the mines, 98 per cent of which could be claimed by members of the association. Senator Hayden contends that his scheme would bring all operators under control of the government, whether shipping in interstate commerce or not.

Further measures aimed at control of the coal industry were foreshadowed in remarks of Senator Costigan, Colorado, on June 24. He declared that the time was ripe to bring all basic industries under government control, and announced that he intended to develop a control plan for the coal industry during the summer.

Coal Output Still Lower

Bituminous coal production dropped still further in June to 17,712,000 net tons, according to preliminary estimates by the U. S. Bureau of Mines. Output in May was 18,384,000 tons, while in June, 1931, production was 29,185,000 tons. Anthracite production dropped to 2,545,000 net tons in June, against 3,278,000 tons in May and 4,544,000 tons in June, 1931.

Total production of bituminous coal in the first six months of 1932 was 144,551,000 net tons, a decline of 23.9 per cent from the output of 189,797,000 tons in the corresponding period of 1931. Anthracite production in the first six months of 1932 was 24,157,000 net tons, a decrease of 23.4 per cent from the corresponding 1931 figure of 31,542,000 tons.

Appalachian Coals, Inc., Named In Injunction Proceedings

Injunction proceedings against 136 operating companies and one individual in the southern high-volatile fields, all participating in Appalachian Coals, Inc., were instituted in the U. S. District Court, Lynchburg, Va., June 29. The petition charges that the defendants have entered into a conspiracy and combination to restrain and monopolize 55 to 91 per cent of the coal consumed in a number of cities in western and central Ohio and 33 to 80 per cent of the coal consumed in North and South Carolina, Georgia, Kentucky, Tennessee, Virginia and West Virginia by eliminating independent and competitive action among themselves, and by controllng and regulating the supply, distribution, and price of bituminous sold by them. The petition further charges that if a favorable decision is rendered, other districts east of the Mississippi, whose coal is more or less in competition with coal sold by the defendants, will, in accordance with the plan adopted by representatives of the National Coal Association, Dec. 3, 1931, form similar selling agencies to control and regulate at least 70 per cent of the trade east of the Mississippi.

The principal purpose of the companies participating in Appalachian Coals, according to the petition, is to obtain a higher price for their product through the employment of the uniform sales contract. The defendants also, it is stated, intend that their efforts to increase their realization shall be made more effective by adoption of the plan in other districts east of the Mississippi, with consequent increase in the price and decrease in the quantity of competing coal.

Employees' Aid Plan Put in Force By Alabama Fuel & Iron Co.

Alabama Fuel & Iron Co., Birmingham, Ala., as a part of its plan for aiding its employees during the present slack running time, has allotted to each of its 1,600 men a parcel of ground. Employees are required to work their plots, and the company has provided an agricultural expert, implements and mules, canning and storage plants in each of its communities in St. Clair and Shelby counties, and sufficient hogs to insure a meat supply during the coming winter. Seed is furnished at cost. The company also plans to paint and improve its houses during the depression, and will furnish all the necessary material for this work. Occupants of the houses will do the work at regular rates of pay, thus augmenting their earnings in the mines.

Prospects Brighter for Illinois Agreement; Wages Cut in Northern West Virginia

HOPES for a new wage agreement providing for a basic scale of "something under $5" a day were growing in Illinois at the end of a month of difficult negotiations, which were again initiated by Governor Emmerson on June 9 after the failure of previous conferences. Another break on June 18 was avoided after a conference at which the Governor proposed arbitration.

Union officials prevented the ratification of a $4 scale in Indiana last month. This scale, indorsed by a subcommittee of the general scale committee on June 8, was to have been submitted to the miners on June 17, but the referendum was called off after a stormy meeting of district officials on June 16. The scale was later referred to a special convention of the miners and rejected by that body on June 24. Operators threatened to reopen non-union, and the rank and file of the men initiated steps for forcing a referendum to approve the scale.

A move by President Lewis of the United Mine Workers to effect a two-state agreement ended in failure June 20 when Indiana operators refused to participate, on the ground that they already had agreed with District 11 on a new scale.

Wage reductions by a number of northern West Virginia coal companies, including the Consolidation Coal Co. and the Bethlehem Mines Corporation, precipitated a series of clashes between the United Mine Workers, its sympathizers, and the non-union companies and miners. Inability to compete in the eastern markets was given as the reason for the cut. The new non-union scales went into effect on June 16, and, in general, provide for a loading rate ½ to 2½c. higher than the union scale, depending upon the company. Old and new rates of the Consolidation Coal Co. for certain classes of labor are given in the following table, together with the corresponding union rates:

	Consolidation Scale New, Per Ton	Consolidation Scale Old, Per Ton	Union Scale, Per Ton
Loading, machine mining	$0.240	$0.300	$0.225
Loading, pick mining	0.290	0.360	0.285
Cutting	0.035	0.045	0.038
	Per Day	Per Day	Per Day
Motormen	$3.04	$3.60	$2.70
Tripriders	2.88	3.40	2.70
Trackmen, main line	2.96	3.50	....
Trackmen and timbermen	2.88	3.40	2.70
Track and timber helpers	2.56	3.10	2.40
Slatemen	2.56	3.10	2.40
Inside common labor	2.56	3.10	2.40
Dumpers	2.64	3.20	....
All other tipplemen	2.56	3.12	2.10
Picking table labor, greasers, outside common labor	2.56	2.80	2.40
Blacksmiths—			
First class	3.44	4.32	3.30
Second class	2.56	3.12	3.00
Car repairmen	3.04	3.60	....
Helpers	2.56	3.12	....

On June 16, part of the force at the Carolina mine of the Consolidation Coal Co. struck, and on the same day Van A. Bittner, international representative, United Mine Workers, asserted that all Consolidation miners were applying for membership in the union. Dissatisfaction later spread to the Monongah and Rivesville mines of the company, and on June 20, 1,000 of the company's employees appeared at the Consolidation offices to request that the company enter into an agreement with the union. Picketing started the same day at the Paisley mines in the Scotts Run region, and resulted in the killing of a union sympathizer and the wounding of ten others by mine guards on June 23.

Shortly after the announcement of the reductions, Bittner invited all the non-union companies in northern West Virginia to attend a conference on June 28 for the purpose of negotiating a uniform wage contract. This invitation was ignored by the companies addressed, with the result that a strike at their operations was called for July 4.

Following a strike early in June, employees of the Pittsburgh Terminal Coal Corporation ratified a new wage scale to go into effect on July 1. The agreement carries the following rates:

	Per Ton
Loading, machine cutting	$0.360
Loading, pick mining	0.500
Cutting	0.065
	Per Day
Motormen, drivers, cagers and snappers	$3.65
Trackmen, wiremen, and pumpers	3.60
Masons	3.40
Other inside labor	3.25
	Per Hour
Picking labor	$0.320
Other tipple men	0.300
Carpenters and coal inspectors	0.400
Blacksmiths	0.450
Carpenters, coal inspectors, blacksmiths' helpers	0.400
Other outside labor	0.320

Ohio production showed an increase in June with the reopening of a number of strike-bound mines, and the withdrawal of 75 National Guardsmen from the coal fields. Approximately 600 men were reported to be working in the Hocking field at the end of the month at a loading rate of 35c. per ton. About 1,500 men were on the job in eastern Ohio. Included in the companies which resumed operations were: Sunday Creek Coal Co., Lorain Coal & Dock Co., Warner Collieries Co., Hanna Coal Co., Clarkson Coal Mining Co., Sauters Coal Co., Ohio & Pennsylvania Coal Co., and Powhatan Mining Co. The Rosewell mine, formerly operated by H. R. Brown & Co., was opened by the Blue Shaft Coal Co. under a union agreement. Clashes growing out of the resumption occurred at the No. 6 mine, Sunday Creek Coal Co.; Unionville mine, Ohio & Pennsylvania Coal Co.; Blaine mine, Lorain Coal & Dock Co.; Provident mine, Clarkson Coal Mining Co.; Wolf Run mine, Warner Collieries Co.; and the Powhatan mine. One hundred National Guardsmen were still on duty at the end of the month.

The Colorado Fuel & Iron Co.'s notice of intention to reduce by 15 per cent its basic wage scale of $5.25 per day brought down upon its head the wrath of the State Industrial Commission last month. Declaring that Colorado miners are "being driven into industrial slavery," the commission disapproved the reduction, though it has no power to enforce its ruling, and recommended that operators stabilize prices rather than cut prices and wages. The action of the Fuel & Iron company was followed by a number of other companies, including the Huerfano, Prior, Empire, Calumet, and Oliver coal companies, and the Juanita Coal & Coke Co.

Following the action of members of the Northern Colorado Coal Producers' Association in reducing the basic scale to $5 per day, the Rocky Mountain Fuel Co. last month negotiated a new contract with the United Mine Workers providing for a day wage of $5.25.

Missionary work by the United Mine Workers in Arkansas and Oklahoma, according to union representatives, has resulted in the negotiation of contracts with the Jim Fork Coal Co., Midland Coal Mining Co., and the Jones Coal Co. These agreements are said to call for a day wage ranging from $4 to $4.44. The drive for membership closed with a parade of miners from the two states at Fort Smith, Ark., followed by a mass meeting at Panama, June 24. Reports also indicate that employees of the Western Coal & Mining Co., Denning, Ark, walked out on June 21 until the company enters into a contract with the union.

After rejection by a majority of the miners in southern Wyoming, United Mine Workers' officials accepted a new agreement providing for a reduction of 20 per cent in the basic wage scale of $6.72. Union officials declared that the I.W.W. influence was responsible for the defeat of the scale, and stated that any strike would be outlawed. The new agreement went into effect July 1, and the majority of the miners were expected to answer the whistle.

Illinois Institute Meets

With 90 people in attendance, the Illinois Mining Institute held its annual summer meeting and boat trip on the Steamer "Cape Girardeau" from June 10 to June 12. At the first technical session on June 11, with C. J. Sandoe, vice-president, West Virginia Coal Co. of Missouri, St. Louis, Mo., presiding, the following papers were presented: "Mining Laws in Illinois and Other States," J. W. Starks, superintendent, Peabody Coal Co., Langleyville, Ill.; "Safety in Illinois Mines," A. U. Miller, associate mining engineer, U. S. Bureau of Mines, Vincennes, Ind. Charles F. Hamilton, vice-president, Pyramid Coal Corporation, Chicago, presided at the second session. Paul Halbersleben, general superintendent, O'Gara Coal Co., Harrisburg, Ill., presented a paper on "Standardization of Mine Timber, Sizes and Specifications."

Permissible Plates Issued

Three approvals of permissible equipment were issued by the U. S. Bureau of Mines in May, as follows:

(1) Sullivan Machinery Co.; Type CR-2 shortwall mining machine; 50-hp. motor, 250-500 volts, d.c.; Approvals 243 and 243A; May 18.

(2) Mine Safety Appliances Co.; Edison Model E animal lamp; Approval 1010; May 26.

(3) Koehler Mfg. Co.; Wheat single-cell signal lamp; Approval 1011; May 26.

Iowa Fuel Conference Held

Utilization of Iowa coal for domestic and industrial purposes was the theme of the first Iowa Fuel Conference, held at Des Moines, June 16-18, with engineers, coal operators, retailers, railroad men, and purchasing agents in attendance. Speakers at the conference were: J. H. Drabelle, mechanical engineer, Iowa Railway & Light Co.; Prof. H. L. Olin, chemical engineering division, University of Iowa; J. L. Harrington, Whiting Stoker Corporation; C. V. Beck, Lumaghi Coal Co.; W. H. Meeker, mechanical engineering department, and O. R. Sweeney, Iowa State College; and H. R. Stade, Carrier Engineering Corporation.

Mines Hang Up Safety Records

Block Coal & Coke Co., Block, Tenn., has won the annual prize of the Southern Appalachian Coal Operators' Association for the longest period of operation without lost-time injuries. The mine, which has an average of 285 employees, operated twelve months without a lost-time injury.

Intensive education of foremen and miners in mine safety and accident prevention is credited with reducing the compensation cost of the Stonega Coke & Coal Co. from $99,000 per year in 1927 to $23,000 in 1931, acocrding to a report submitted to the Virginia Supervisor of Trade and Industrial Education by Stonega officials. On a per-ton basis, compensation for all lost-time injuries was cut from 3c. in 1927 to 1c. in 1931.

Presentation of the Joseph A. Holmes Safety Association award to the Bird Coal Co., Tire Hill, Pa., for working four years without a fatal accident took place on June 17. George Winder, superintendent, acting for the employees, accepted the award.

No. 1 mine, Phelps Dodge Corporation, Dawson, N. M., was awarded the "Sentinels of Safety" trophy, donated by the *Explosives Engineer* for the most outstanding safety accomplishment among bituminous mines during 1931. The mine worked 118,661 man-hours in 1931 without a single lost-time accident. Highland No. 2 mine, Jeddo-Highland Coal Co., Jeddo, Pa., which worked 299,560 man-hours with only 15 lost-time accidents, won the award in the anthracite division.

Coal-Oil Fuel Successful

Experiments with a new colloidal fuel composed of a mixture of 40 per cent of fuel oil and 60 per cent of pulverized coal by weight on the liner "Scythia" were declared to be successful by the Cunard company in a statement on June 24. The trial showed, it is declared, that the new fuel can be handled with the same facility as oil, and that it promises to be 15 to 20 per cent cheaper, even at present low prices for that fuel.

Committee of Ten Meets

One hundred representatives of the solid fuel and allied manufacturing industries discussed ways and means of furthering consumer satisfaction in the utilization of solid fuels at the annual meeting of the Committee of Ten—Coal and Heating Industries, held in Chicago, June 20. The following officers were elected: chairman, H. A. Glover; vice-chairman, Lyle H. Dayhoff, American Wholesale Coal Association; secretary, Carlyle M. Terry, Anthracite Institute; treasurer, Harry H. Kurtz, Stoker Manufacturers' Association and Midwest Stoker Association; assistant secretary-treasurer, Marc G. Bluth; managing director, Oliver J. Grimes.

Coal Mine Fatalities Decline

Coal-mine accidents caused the death of 41 bituminous and 12 anthracite miners in May, 1932, according to information furnished the U. S. Bureau of Mines by state mine inspectors. This compares with 48 bituminous and 32 anthracite fatalities in April and 76 bituminous and 38 anthracite deaths in May, 1931. The death rate at bituminous mines dropped to 2.23 per million tons in April, while the anthracite fatality rate decreased to 3.66. Comparative figures are as follows:

	May, 1932	April, 1932	May, 1931
Bituminous Mines			
Production, 1,000 tons	18,384	20,300	28,314
Fatalities	41	48	76
Death rate per 1,000,000 tons	2.23	2.36	2.68
Anthracite Mines			
Production, 1,000 tons	3,278	5,629	5,005
Fatalities	12	32	38
Death rate per 1,000,000 tons	3.66	5.68	7.59

Comparative fatality rates for 1932 and 1931 are given in the following table:

Fatalities and Death Rates at United States Coal Mines, by Causes*

Cause	Bituminous: Number Killed	Bituminous: Killed per 1,000,000 Tons	Anthracite: Number Killed	Anthracite: Killed per 1,000,000 Tons	Total: Number Killed	Total: Killed per 1,000,000 Tons
January-May, 1931						
All causes	460	2.864	191	7.075	651	3.470
Falls of roof and coal	265	1.650	100	3.704	365	1.946
Haulage	88	.548	23	.852	111	.592
Gas or dust explosions:						
Local explosions	1	.006	6	.222	7	.037
Major explosions	41	.255	5	.185	46	.245
Explosives	6	.037	15	.556	21	.112
Electricity	20	.125	1	.037	21	.112
Surface and miscellaneous	39	.243	41	1.519	80	.426
January-May, 1932						
All causes	359	2.830	105	4.858	464	3.126
Falls of roof and coal	193	1.522	61	2.822	254	1.711
Haulage	58	.457	15	.694	73	.492
Gas or dust explosions:						
Local explosions	2	.016	...	.....	2	.014
Major explosions	44	.347	...	.....	44	.296
Explosives	7	.055	8	.370	15	.101
Electricity	16	.126	4	.185	20	.135
Surface and miscellaneous	39	.307	17	.787	56	.377

*All figures are preliminary and subject to revision.

Virginia Explosion Kills Ten

Ten men were killed in an explosion in the Lonesome Branch mine of the Splashdam Coal Corporation, Bartlick, Va., June 13. Ignition of coal dust is believed to have caused the disaster. Little damage was done to the mine.

Personal Notes

HARRY L. GANDY, New York City, president, Sheridan-Wyoming Coal Co., was elected a member of the board of directors of the National Coal Association last month.

DOUGLAS MILLARD, manager of fuel sales, Colorado Fuel & Iron Co., was elected president of the Colorado and New Mexico Coal Operators' Association at the annual meeting in June. G. C. DAVIS, manager, Stag Canon Branch, Phelps Dodge Corporation, was chosen vice-president, and F. O. SANDSTROM was re-elected secretary-treasurer and traffic manager.

J. A. MEYERS, president, Apex Coal Co., was chosen president of the Southwestern Interstate Coal Operators' Association at the annual meeting held in June. Other officers are: Vice-president, IRA CLEMENS, Commercial Fuel Co.; K. A. SPENCER, vice-president and chief engineer, Pittsburg & Midway Coal Mining Co.; J. F. KLANER, Alston Coal Co.; secretary, GEORGE K. MACKIE, JR., general manager, Clemens Coal Co.; treasurer, W. P. KELLY, vice-president, Kelly-Carter Coal Co.; general commissioner, W. L. A. JOHNSON (re-elected).

T. E. JOHNSON, formerly sales manager, has been elected vice-president of the Hutchinson Coal Co., Fairmont, W. Va., succeeding the late C. H. Jenkins. GEORGE C. GROLOCK, Philadelphia, Pa., and J. L. FINKENBINDER, Cleveland, Ohio, also were chosen vice-presidents in the reorganization necessitated by Mr. Jenkins' death.

GEORGE V. O'HARA, Scranton, Pa., formerly assistant to the general manager, has been made general superintendent of the northern division of the Glen Alden Coal Co., succeeding A. E. Yetter, retired. JOHN R. MOULD, superintendent, Sugar Notch No. 9 colliery, abandoned, has been made superintendent of the Woodward colliery, Westmoor.

JAMES A. MEEHAN, Johnstown, Pa., has been appointed general superintendent of central Pennsylvania mining operations of the Producers' Coal & Coke Co.

W. J. JENKINS, president, Consolidated Coal Co. of St. Louis, St. Louis, Mo., was appointed president and commissioner of the Illinois Coal Operators' Association last month, vice the late Joseph D. Zook, of Chicago.

Obituary

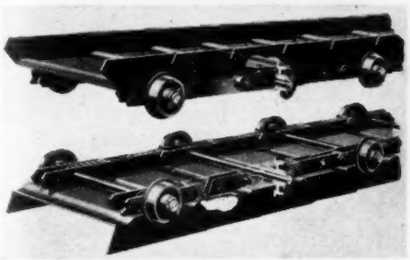
THOMAS MAHER, 75, president of the Maher & Graff Coal Co., and secretary-treasurer, Maher Coal & Coke Co., died at Pittsburgh, Pa., June 9.

JOHN A. ESSER, president, J. A. Esser Coke Co., Esserville, Va., died at his home at Norton, Va., last month at the age of 83.

WHAT'S NEW
IN COAL-MINING EQUIPMENT

Steel Apron Conveyor

For long-time operation under severe conditions the "Gravity-Seal" steel apron conveyor is offered by the Webster & Weller Mfg. Cos., Chicago. The "Gravity-Seal" feature is based upon a new method of attaching the conveyor pans to the chains by means of a patented pivot link which, in conjunction with other construction features, causes the pans to overlap



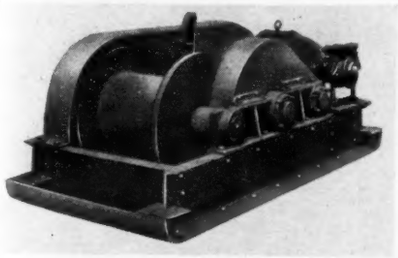
"Gravity-Seal" Steel Apron Conveyor

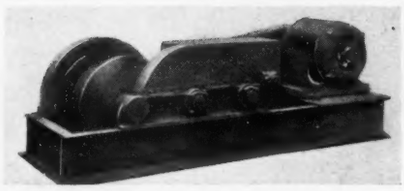
snugly to eliminate material loss, yet makes the conveyor flexible enough to travel evenly and without strain around the sprockets. "Gravity-Seal" construction is applicable to both apron conveyors and feeders.

Car-Handling Equipment

Brown-Fayro Co. Johnstown, Pa., has developed a new triple-geared hoist (Model HKd) for handling trips of mine cars of the size usually hauled by main-line locomotives. The hoist is designed for a normal working load of 12,000 lb., and may be geared for rope speeds of 20 to 50 ft. per minute. The rope drum (drum diameter, 14 in.; flange diameter, 24 in.; face, 16½ in.) has a capacity of 525 ft. of ¾-in. wire rope. Motor size varies from 7½ to 15 hp. The hoist may be equipped with a new automatic brake for holding the load, especially when the hoist is remotely controlled. The brake employs the free-wheeling principle and is mounted on the motor shaft. It permits the motor to run in the normal winding direction, but automatically opposes paying out of the rope.

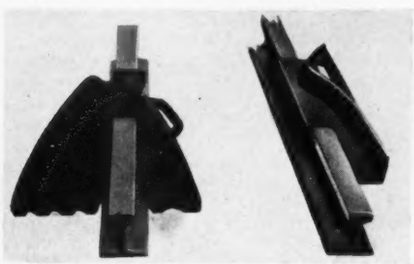
Model HKd Hoist





Model HKe Combination Hoist and Car Retarder

A second item lately added to the Brown-Fayro line is the Model HKe combination car retarder and puller, designed primarily



"Brownie" Rerailer and Derailer

for handling railroad cars where it is desired not only to control the lowering of the car but also to move it in the reverse direction. HKe equipment is said to be especially adapted to layer, or "sandwich," loading. The hoist is capable of a normal rope pull of 8,500 lb., sufficient to handle one loaded or two empty cars on a grade of 2 per cent. It is geared for lowering speeds of 50 to 200 ft. per minute and for a hauling speed of 50 ft. per minute. A two-speed motor is furnished for rapid handling of the rope at 150 ft. per minute in connecting the rope to cars or in winding it in. A Thrustor brake is provided to prevent shock in stopping cars, and the

Brown-Fayro Snub Sheave

hoist is controlled magnetically by push-buttons located at strategic points.

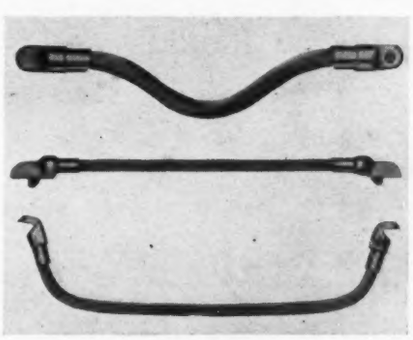
For rerailing cars and locomotives, the Brown-Fayro Co. offers the "Brownie" rerailer of annealed electric-furnace alloy steel, said to be able to handle wheels from the largest mine locomotive wheel to the smallest mine-car wheel without pinching or binding on any size rail. No tools are required, the company states, and the rerailers have handles for ease in carrying. Deep toe calks grip the rails. Three sizes are available for rail weights up to 80 lb. and locomotive weights up to 40 tons.

For preventing damage by runaway cars at the face, the company offers the "Brownie" derailer in two sizes (20-40- and 30-60-lb. rails). The derailer is cast from electric furnace alloy steel and is equipped with a handle for easy carrying.

The Brown-Fayro Co. also announces a new type of snub sheave, commonly used with car retarders where a heavy load is braked to a sudden stop. The shock is absorbed by a heavy coil spring, thus protecting both rope and retarder. Several sizes are available, including the one illustrated here, which has a throat diameter of 15 in. and is grooved for a ¾-in. rope. This sheave is arranged for wick oiling and is rated at 20,000 lb., equivalent to a rope pull of 10,000 lb.

Rail Bonds and Strain Clamp

A new line of rail bonds, known as the O-B Duoweld line, has been placed on the market by the Ohio Brass Co., Mansfield, Ohio, for application with either the electric arc process, using steel welding rod, or with the gas-weld process, using a copper-alloy-flux welding rod. According to the company, positive union between the strand and the terminal of the new bond is assured by flash butt-welding of the exact



Duoweld Rail Bonds. Top—No. 2, for Application to Rail Head; Center—No. 3, for Application to Rail Base; Bottom—No. 5, Cross Bond

ends of the copper strand to the steel terminal, giving a weld that is stronger than the conductor itself, while at the same time the necessary heat is localized so that the molecular structure of the strand is unchanged. In addition to a type for cross-bonding, two types are available for head-of-rail bonding and two for base-of-rail

Universal Strain Clamp

bonding. Ease and cheapness of application are stressed by the company.

Light weight, exceptional strength, and low cost are claimed for the new Universal strain clamp developed by the Ohio Brass Co. for use in stringing distribution lines, substation buses, low-current transmission lines, and overhead ground wires. An ultimate strength of 10,000 lb. is claimed for the clamp, which is designed for a high slip strength. By means of a reversible keeper piece, A.C.S.R. or copper conductors from No. 6 to 4/0 may be accommodated. Clamps are provided with or without a ball-and-socket eye, and the clevis may be connected directly to any of the other standard O-B clevis-type suspension insulators and hardware.

Free-Running Powders

A new series of explosives, known as "Red Cross Blasting Nos. 2, 3, and 4 F.R.," has been developed by the explosives department, E. I. duPont de Nemours & Co., Wilmington, Del. These so-called free-running powders, the company states, are dynamites of special grades in loose form. Field experience, it is declared, shows that 60-75 lb. of the free-running powder will replace 100 lb. of black powder.

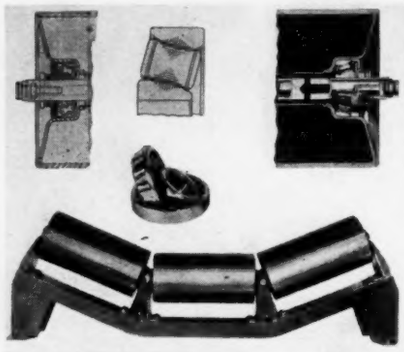
Oil Seal for Bearings

Aetna Ball Bearing Mfg. Co., Chicago, has developed a new oil seal for use on shafts from ½-in. diameter up. The following points are stressed by the company: ciltight at highest operating temperatures, and with vertical and horizontal stationary, rotating, and oscillating shafts at low and high speeds; seals oil, grease, water, and other liquids; has low static and dynamic friction loss; is self-contained, with no moving parts; is ready for immediate use; has minimum width; is available in all standard sizes; has accurately ground outside diameter; and is interchangeable with other types of grease seals.

Aetna Standard Oil Seal

Anti-Friction Conveyor Carrier

A new anti-friction conveyor carrier equipped with Shafer self-aligning roller bearings for both thrust and radial loads is announced by the Barber-Greene Co., Aurora, Ill. Each size of carrier has but one roller unit, making the units and parts interchangeable. Carriers themselves are made to interchange with any other standard carriers. Rollers are 5½ in. in diameter, with pressed steel ends, in which the outer roller race is inserted under pressure. The inner tube is 1⅛ in. in diameter. The spindle is ¾ in. in diameter and is drilled and tapped at each end for grease and Alemite lubrication. Two flats are provided to lock the grease-seal washers, and the spindle is drilled and reamed at each end for taper pins.



Details of Barber-Greene Conveyor Carrier

Bearings are held in place by two labyrinth seal washers, shimmed for tightness. In case of wear, the taper pin on one side is taken out, a shim inserted, and the taper pin driven back in to tighten up the bearing. Load rating of each roller is 450 lb. Allowing a proper factor of safety, each carrier, it is declared, will carry 600 lb.

Vibrator to Suit Material

Stephens-Adamson Mfg. Co., Aurora, Ill., announces a new "custom-built" vibrating screen, which it is prepared to furnish with amplitude, screen angle and frequency to suit the material to be screened. The screen, consisting of screen body, vibrating mechanism and subframe, is assembled by the company to fit definite data on material, sieve analysis and required capacity. The company also has developed a quick-change screen panel, consisting of a full-size screen cloth with a stiff cross angle brazed to each end. The panel is installed by sliding it up the tubular deck supports until the ends of the upper cross angle drop into sockets in the side frames. Stretching levers are then slipped onto the lower angle and tightened. A stabilizer unit is supplied to hold the screen body at the desired screening angle.

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